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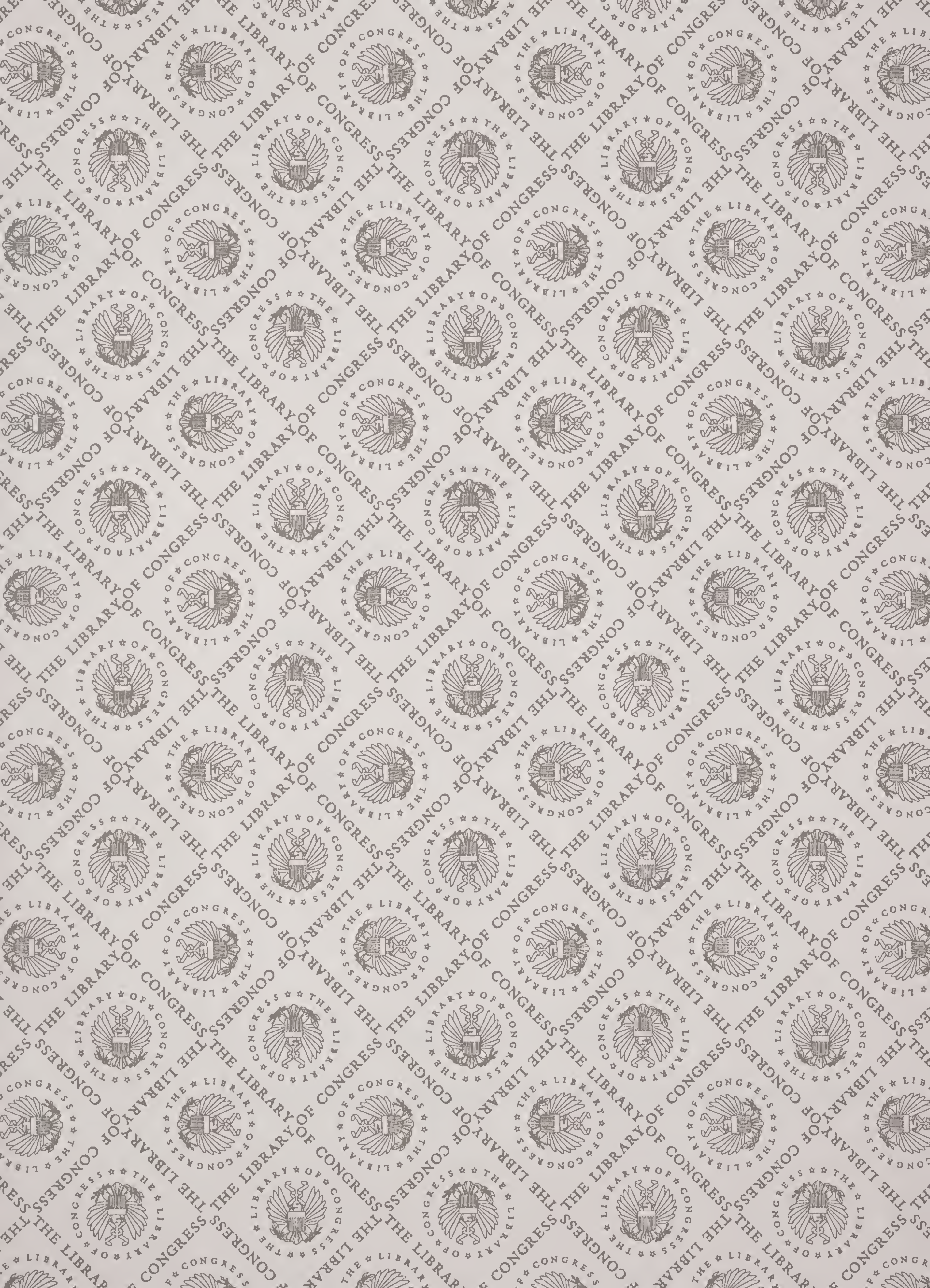
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EPA-454/R-00-002
March 2000

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NATIONAL AIR POLLUTANT EMISSION TRENDS, 1900 - 1998

U. S. EPA and the States -

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NATIONAL AIR POLLUTANT

EMISSION TRENDS

1900 - 1998

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Foreword

This document presents the most recent estimates of national emissions of the criteria air pollutants. The emissions of each pollutant are estimated for many different source categories, which collectively account for all anthropogenic emissions. The report presents the total emissions from all 50 States and from each EPA region in the country. These estimates are updated annually.

This report tracks changes in national emissions since passage of the Clean Air Act Amendments of 1990. The emission trends are the net effect of many factors, including changes in the nation's economy and in industrial activity, technology, consumption of fuels, traffic, and other activities that cause air pollution. The trends also reflect changes in emissions as a result of air pollution regulations and emission controls. These reports will serve as a measure of our nation's progress in reducing air pollution emissions as a result of mandatory and voluntary controls and of continuous changes in national activity.

In addition to the extensive coverage of criteria air pollutant emissions from anthropogenic sources in the United States, this year's report continues to provide limited coverage of State-derived biogenic, greenhouse gas, and air toxic emissions, and emissions for Canada and Europe. Preliminary estimates are presented for the years 1990 through 1998. Final estimates (including refinements to the data used to estimate emissions) will be presented in future reports.

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Acronyms and Abbreviations

AIRS	Aerometric Information Retrieval System
AIRS/AFS	AIRS Facility Subsystem
ARD	Acid Rain Division
BACT	best available control technology
BEA	U.S. Department of Commerce, Bureau of Economic Analysis
BEIS2	Biogenic Emission Inventory System version 2
BTS	U.S. DOT, Bureau of Transportation
Btu	British thermal unit
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CEM	continuous emission monitor(ing)
CFCs	chloroflurocarbons
CH_4	methane
CHIEF	Clearinghouse for Inventories and Emission Factors
CNG	compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
CORINAIR	Coordination of Environmental Air
DOE	Department of Energy
DOT	Department of Transportation
EEA	European Environment Agency
EFIG	EPA, OAQPS, Emission Factor and Inventory Group
EGAS	Economic Growth Analysis System
EIA	U.S. DOE, Energy Information Administration
EIIP	Emission Inventory Improvement Program
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe
EPA	U.S. Environmental Protection Agency
ES	Executive Summary
ETC/AEM	European Topic Center on Air Emissions
ETS	Emissions Tracking System
FAA	Federal Aviation Adminstration
FIPS	Federal Information Processing Standards
FIRE	Factor Information Retrieval
FR	Federal Register
FTP	Federal Test Procedure
GACT	generally achievable control technology
GCVTC	Grand Canyon Visibility Transport Commission
GDP	gross domestic product
gpg	grams per gallon
gpm	grams per mile

GSP	gross State product
HAPs	hazardous air pollutants
HCFC	hydrochloroflurocarbon
HDDV	heavy-duty diesel vehicle
HDGV	heavy-duty gasoline vehicle
HFCs	hydroflurocarbons
ID	identification (code)
IPCC	Intergovernmental Panel on Climate Change
LDDT	light-duty diesel truck
LDDV	light-duty diesel vehicle
LDGT	light-duty gasoline truck
LDGV	light-duty gasoline vehicle
LDT	light-duty truck
LDV	light-duty vehicle
LPG	liquefied petroleum gas
MACT	maximum available control technology
MECs	Manufacturing Consumption of Energy
MMTCE	million metric tons carbon-equivalent
MW	megawatts
N_2O	nitrous oxide
NAA	nonattainment area
NAAQS	National Ambient Air Quality Standard
NADB	National Allowance Data Base
NAPAP	National Acid Precipitation Assessment Program
NEC	not elsewhere classified
NET	National Emissions Trends (inventory)
NH_3	ammonia
NMVOC	nonmethane volatile organic compounds
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NPI	National Particulates Inventory
NSPS	New Source Performance Standards
NTI	National Toxics Inventory
O_3	ozone
OAQPS	EPA, Office of Air Quality Planning and Standards
OMS	EPA, Office of Mobile Sources
OTAQ	EPA's Office of Transportation and Air Quality
OTAG	Ozone Transport Assessment Group
Pb	lead
PCB	polychlorinated biphenyl
PEI	periodic emission inventory
PFC	perfluorocarbon
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
POM	polycyclic organic matter
ppm	parts per million
psi	pounds per square inch

QA	quality assurance
QC	quality control
RACT	reasonably available control technology
REMI	Regional Economic Models, Inc.
RFG	reformulated gasoline
RSD	Regulatory Support Document
RVP	Reid vapor pressure
SCC	source classification code
SEDS	State Energy Data System
SF_6	sulfur hexafluoride
SIC	Standard Industrial Classification (code)
SIP	State Implementation Plan
SO_2	sulfur dioxide
SUV	sport utility vehicle
TP	total particulates
tpy	tons per year
TRENDS	The Representative Emissions National Data System
TRI	Toxic Release Inventory
TSDF	hazardous waste treatment, storage, and disposal facility
TSP	total suspended particulate matter
TTN	Technology Transfer Network
UNFCCC	United Nations Framework Convention on Climate Change
U.S.	United States
USDA	U.S. Department of Agriculture
USFS	USDA Forest Service
VMT	vehicle miles traveled
VOC	volatile organic compound(s)

Acknowledgement

This report was prepared with the help of many people. The EPA wishes to acknowledge the assistance of the Emission Inventory Trends Team of the Emission Factor and Inventory Group, the National Toxics Inventory Team of the Emission Factor and Inventory Group, the Utilities Emissions Representatives of the Clean Air Markets Division; the Nonroad Team of the Office of Transportation and Air Quality; and the Annual Reporting of Green House Gases Report Team of the Climate Policy and Programs Division; The agency also wishes to acknowledge the data and information that was provided by numerous people from Government agencies and private institutions and organizations. This final document was prepared under Contract Number 68D-70067.

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Executive Summary

ES.1 WHAT INFORMATION IS PRESENTED IN THIS REPORT?

This report presents the United States (U.S.) Environmental Protection Agency's (EPA) latest estimates of national emissions for criteria air pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOC), sulfur dioxide (SO_2), particulate matter (PM) less than 10 microns in aerodynamic diameter (PM_{10}), particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$), and lead (Pb). In addition, estimates of ammonia (NH_3), an important precursor for secondarily formed particles, are also presented. Estimates are presented for the years 1900 to 1998. Estimates for three criteria pollutants, NO_x, SO_2, and VOC, have been extrapolated back to 1900. Criteria pollutants are those for which ambient air standards have been set, based on established criteria for risk to human health and/or environmental degradation.

Data on emissions of hazardous air pollutants (HAPs), or air toxics, greenhouse gases (carbon dioxide [CO_2], methane [CH_4], nitrous oxide [N_2O], hydrofluorocarbons {HFCs], perfluorocarbons (PFCs), and sulfur hexafluoride [SF_6]), and biogenic sources are also included in this report for the United States. As a point of comparison, data for Canada for 1995 and for Europe for 1996 are presented for the criteria air pollutants.

Figures ES-1 and ES-2 present the long-term trends in the criteria air pollutant emissions from 1900 through 1998. Most of the criteria air pollutant emission levels peaked around 1970. PM_{10} emissions peaked earlier (around 1950) since smoke and particulates were the first pollutants to be regulated. Between 1970 and 1998 emissions for all criteria pollutants have generally declined (except for NO_x), even though vehicle miles traveled (VMT) and gross domestic product (GDP) increased. For the last 2 years, SO_2 has shown a small increase in emissions. These air pollution decreases are attributable to the Clean Air Act (CAA) regulations beginning in 1970 and continuing into the 1990s. (Intermittent economic recession and improved manufacturing practices have also played a role.) Although not shown in these figures, the trend in $PM_{2.5}$ mirrors that of PM_{10} over the period that estimates have been made for $PM_{2.5}$ (1990-1998). NH_3 has shown a modest increase over this same time period.

ES.2 WHAT ARE THE CURRENT EMISSION LEVELS?

Tables ES-1 and ES-2 present the most current emission estimates for the criteria and other air pollutants in the United States. U.S. criteria pollutant emissions decreased for CO, VOC, and NO_x, and increased for Pb, SO_2, and PM_{10} from the previous year. The increase in SO_2 emission estimates is a result of a modest increase in emissions in the electric utility and industrial process sectors, probably fueled by the strong economy. The reduction in CO and VOC emissions results from a sharp decrease in emissions from forest wildfires, as well as a decrease in mobile source emissions as a result of the use of new fuels (reformulated gasoline, oxygenated fuels, and lower Reid vapor pressures [RVP]). Particulate fugitive dust emissions from construction sources, paved roads, and unpaved roads increased due to the increases in construction and VMT. The most recent available Canadian data for 1995 and Europe for 1996 are summarized in Table ES-3.

A description of those source categories whose methods used for estimating CO, NO_x, VOC, SO_2, PM_{10}, $PM_{2.5}$, NH_3, and Pb changed during the last year can be found in Chapter 5 of this report, while information on methods that did not change can be found in the National Air Pollutant Emission *Trends* Procedures Document.[1]

ES.3 WHAT ARE THE TRENDS IN POLLUTANT EMISSIONS?

The level and composition of economic activity in the nation, demographic influences, meteorological conditions, and regulatory efforts to control emissions affect the trends in criteria air pollutant emissions. The emissions resulting from these economic, demographic, and regulatory influences are presented in Figures ES-1 and ES-2. The changes in emissions are presented in Table ES-4 for several time periods. Up until the 1950s, the greatest influence on emissions were economic and demographic. Emissions grew as the economy and population increased; emissions declined in periods of economic recession. Dramatic declines in emissions in the 1930s were due to the Great Depression. More recent recession in the mid/late-1970s (largely a result from disruptions in the world oil markets) and early 1990s also led to decreases in emissions.

Emissions also increase as a result of a shift in the demand for various products. For example, the tremendous increase in demand for refined petroleum products, especially motor gasoline after World War II, increased emissions associated with petroleum refining and on-road vehicles. Increased economic production as a result of World War II raised emissions to levels higher than those of the pre-Depression Era. The declines in the 1940s through 1970s in residential wood combustion resulted from the abundant supply, low relative prices, and convenience of fossil fuel-generated electricity.

In the 1950s the States issued air pollution statutes generally targeted toward smoke and particulate emissions. It was not until passage of the CAA as amended in 1970 (Congress passed the original CAA in 1963) that major strides were made in reducing air pollution. The 1970 Amendments created the EPA and charged it with three major tasks: 1) set National Ambient Air Quality Standards (NAAQS); 2) develop motor vehicle emission standards; and 3) set new source performance standards (NSPS). As a result of these standards, CO, VOC, SO_2, and Pb emissions were reduced in the mid-1970s.

The Clean Air Act Amendments of 1990 (CAAA) are beginning to effect emission levels. For some source categories (such as non-road engines), standards began in 1996, but some significant emission reductions are not expected until after the year 2000. The robust U.S. economy in the late 1990s has provided a slight increase in emissions in some source sectors, although the influence of these increases has been largely offset by regulatory programs.

Some emission sources such as wildfires and fugitive dust have been influenced more by meteorological conditions than economic forces. Controls to reduce fugitive dust emissions resulting from the CAAA are beginning to take effect, but are only applied in the PM nonattainment areas (NAAs). The amount of land burned in wildfires varies greatly from year-to-year. Overall emission reductions from wildfires are a result of the U.S. Department of Agriculture's (USDA) Forest Service support of state efforts in fire prevention and early control. For example, in the year 1910, 5,201 fires burned approximately 5 million acres of land, whereas in the year 1990, 11,950 fires burned only one-third of a million acres of land.

More details on the effects of economic, demographic, and regulatory forces on emission levels are explained in Chapter 3.

ES.4 REFERENCES

1. "National Air Pollutant Emission Trends Procedures Document, 1900-1996," EPA-454/R-98-008, U.S. Environmental Protection Agency. May 1998.

2. "Historic Emissions of Sulfur and Nitrogen Oxides in the United States from 1900 to 1980," EPA-600/7-85-009a and b, U.S. Environmental Protection Agency, Cincinnati, OH. April 1985.

3. "Historic Emissions of Volatile Organic Compounds in the United States from 1900 to 1985," EPA-600/7-88-008a, U.S. Environmental Protection Agency, Cincinnati, OH. May 1988.

Table ES-1. 1997 and 1998 National Annual Emission Estimates for Criteria Air Pollutants
(million short tons)

Pollutant	Emissions 1997	 1998
Anthropogenic Emissions		
Carbon Monoxide	94.41	89.45
Lead (thousand short tons)	3.95	3.97
Nitrogen Oxides	24.82	24.45
Particulate Matter (PM_{10})	34.23	34.74
Miscellaneous and Fugitive dust	30.08	30.90
Nonfugitive dust	4.15	3.84
Sulfur Dioxide	19.62	19.65
Volatile Organic Compounds	18.88	17.92
Biogenic Emissions		
Volatile Organic Compounds	28.19	NA
Nitric Oxide	1.53	NA

Table ES-2. 1998 National Annual Emission Estimates for $PM_{2.5}$, Ammonia, and 1990-1993 Hazardous Air Pollutants
(million short tons)

Pollutant	Emissions
Particulate Matter ($PM_{2.5}$)	8.38
Miscellaneous and Fugitive dust	5.46
Nonfugitive dust	2.92
Ammonia	4.94
Hazardous Air Pollutants	5.92

Table ES-3. Annual Criteria Air Pollutant Emission Estimates for Canada (1995) and Europe (1996)
(million short tons)

Pollutant	Canada	Europe
Carbon Monoxide	18.89	55.53
Nitrogen Oxides	2.72	15.31
Total Particulate Matter	17.29	NA
Sulfur Dioxide	2.93	18.53
Volatile Organic Compounds	3.94	16.09

Table ES-4. Percentage Change in National Emissions

Year	Carbon Monoxide	Nitrogen Oxides	Volatile Organic Compounds	Sulfur Dioxide	Particulate Matter (PM_{10})*	Miscellaneous and Fugitive Dust**	Lead
1900 to 1998	NA***	-840	-111	-97	NA	NA	NA
1940 to 1998	5	-232	-4	2	76	NA	NA
1970 to 1998	31	-17	42	37	71	NA	98
1988 to 1998****	25	-1	26	15	26	45	44
1990 to 1998	9	-2	14	17	15	-26	20
1997 to 1998	5	2	5	0	7	-3	-1

Note(s):
- * PM_{10} emissions excluding miscellaneous and fugitive dust sources.
- ** Miscellaneous sources include agriculture and forestry, fugitive dust includes roads and construction, and natural sources include primarily geogenic wind erosion.
- *** NA denotes not available. Negative percent change indicates an increase in emissions.
- **** There are significant changes in fugitive dust emission methodology between the years 1989 and 1990.

Figure ES-1. Trend in National Emissions, NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS, SULFUR DIOXIDE (1900 to 1998), and Directly Emitted PARTICULATE MATTER (PM_{10} [nonfugitive dust sources]; 1940 to 1998)

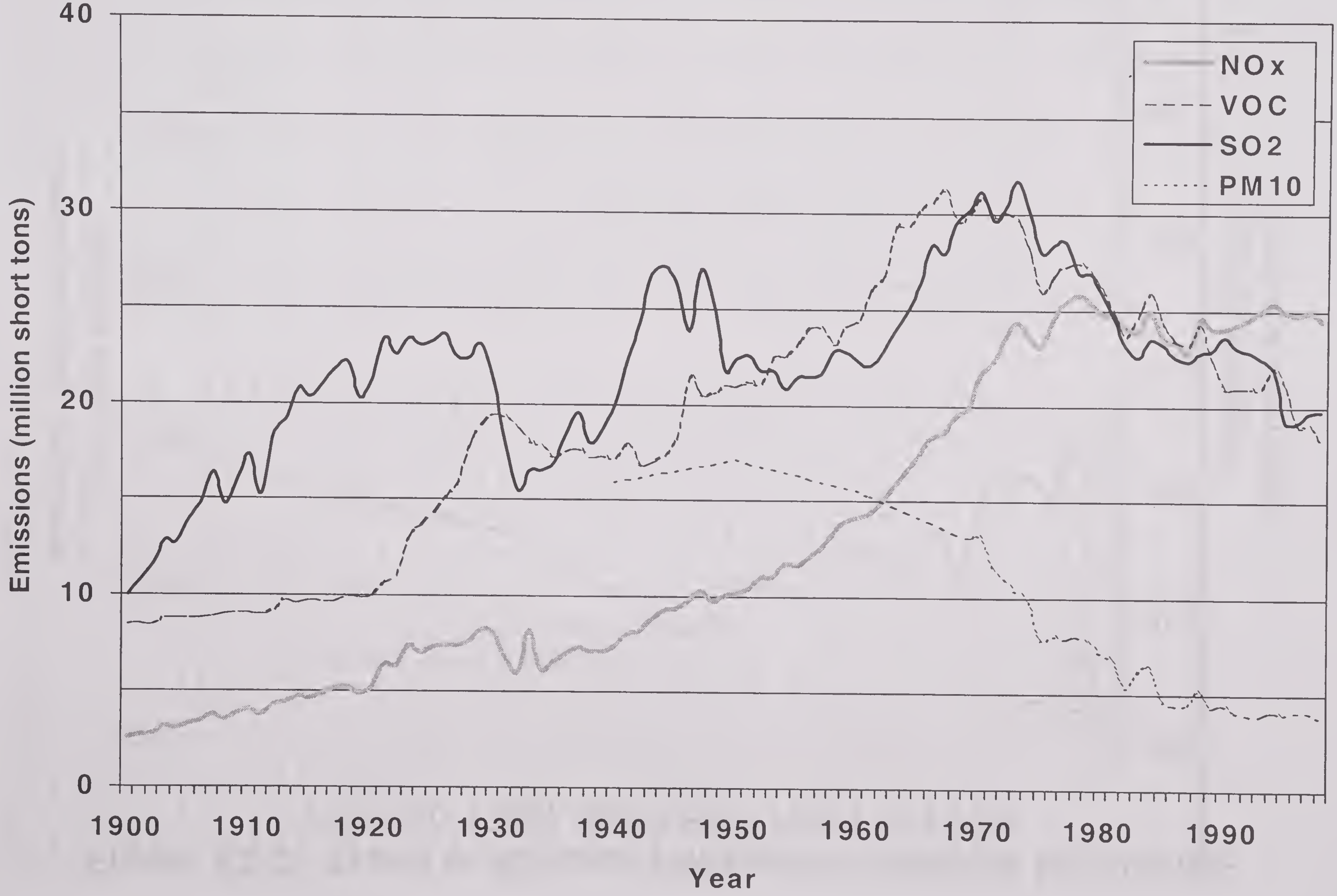
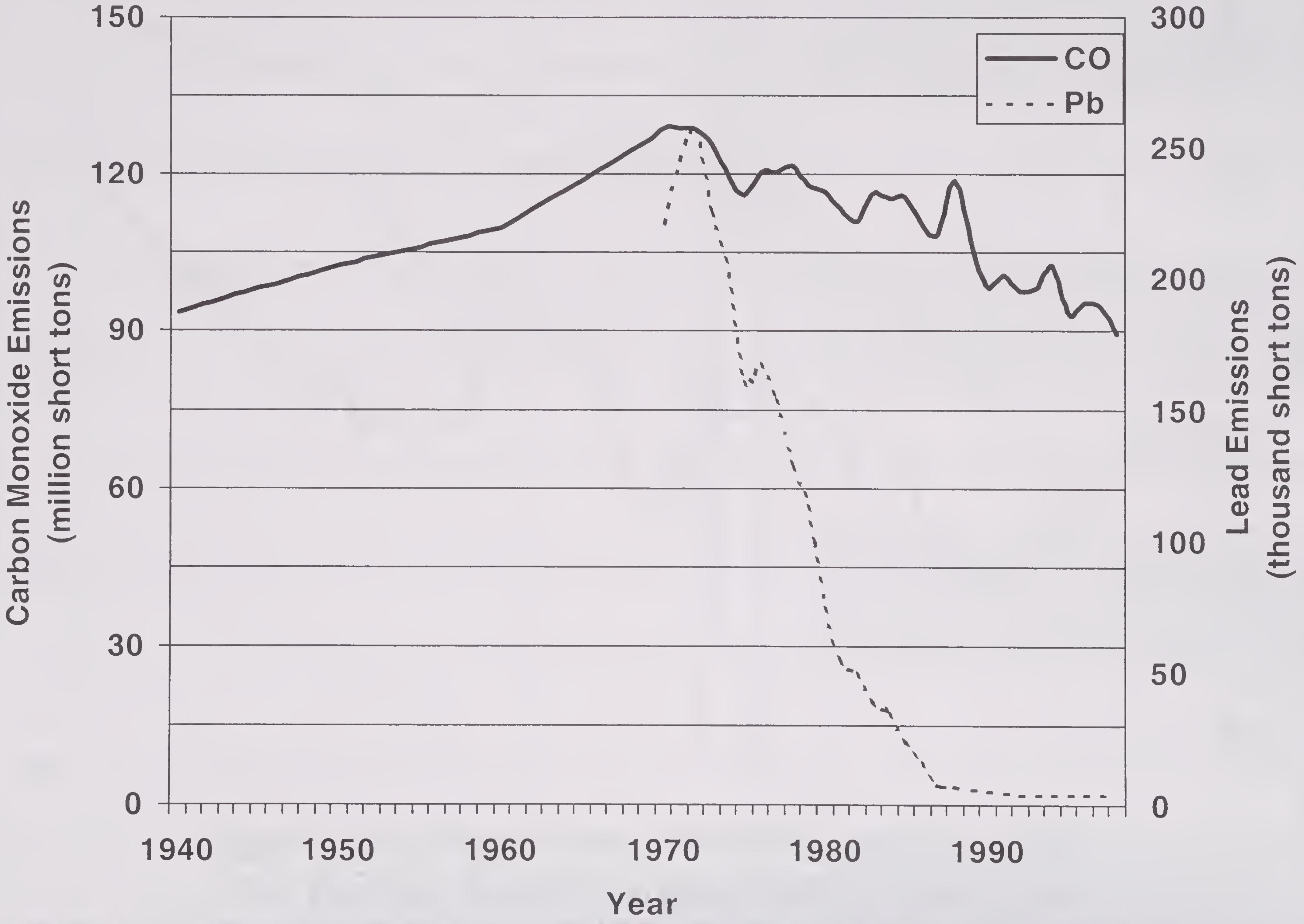


Figure ES-2. Trend in National Emissions, CARBON MONOXIDE (1940 to 1998), and LEAD (1970 to 1998)



Chapter 1.0 Introduction

1.1 WHAT INFORMATION IS PRESENTED IN THIS REPORT?

This report presents the United States (U.S.) Environmental Protection Agency's (EPA) latest estimates of national emissions for criteria air pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs [excludes certain nonreactive organic compounds]), sulfur dioxide (SO_2), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), and lead (Pb). Although not a criteria pollutant, emission estimates for ammonia (NH_3), a compound that plays an important role in the secondary formation of particles, are also presented. The Clean Air Act (CAA) requires that the EPA Administrator publish a list of pollutants that have adverse effects on public health or welfare, and are emitted from numerous and diverse stationary or mobile sources. For each pollutant, the Administrator must compile and publish a "criteria" document. The criteria documents are scientific compendia of the studies documenting adverse effects of specific pollutants at various concentrations in the ambient air. For each pollutant, National Ambient Air Quality Standards (NAAQS) are set at levels that, based on the criteria, protect the public health and the public welfare from any known or anticipated adverse effects. These regulated pollutants are therefore called "criteria pollutants." We describe some of the health effects in section 1.2.

Summaries of ambient air quality measurements collected by federal, State, and local agencies, and the status of compliance with the NAAQS, can be found in the series of annual air quality trends reports, the most recent of which is the *National Air Quality and Emissions Trends Report, 1998* (EPA-454/R-00-003).

Graphs of national emission estimates, beginning in 1900 for NO_x, VOC, and SO_2, aggregated by major source category, are presented in Chapter 3. We provide more detail for these pollutants, and CO and PM_{10} beginning with 1940. Information related to $PM_{2.5}$ and NH_3 starts with 1990, the first year EPA developed estimates for these pollutants. We include additional detail for the current year. This report also contains information on estimation methods that we have updated during the past year. Revised international emissions from Europe and Canada, air toxic emissions, greenhouse gas emissions, and biogenic emissions are also presented.

1.2 WHAT ARE THE HEALTH AND ENVIRONMENTAL EFFECTS OF CRITERIA POLLUTANTS?

CO enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. It affects healthy individuals also but only at higher concentration levels. Exposure to elevated CO levels is associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks.[1] Prolonged exposure to high levels can lead to death.

Nitric oxide (NO) is the principal oxide of nitrogen produced in combustion processes; it is readily oxidized in the atmosphere to nitrogen dioxide (NO_2). Collectively, NO and NO_2 are referred to as NO_x. NO_2 can irritate the lungs and lower resistance to respiratory infection (such as influenza). Nitrogen oxides are an important precursor both to ozone (O_3) and to acidic deposition and may affect both terrestrial and aquatic ecosystems. Atmospheric deposition of nitrogen (nitrate, NO_x, other compounds derived from NO_x) leads to excess nutrient enrichment problems (eutrophication); prominent examples are: Chesapeake Bay and several other nationally important estuaries along the East and Gulf Coasts.[2] Eutrophication can produce multiple adverse effects on water quality and the aquatic environment, including increased nuisance and toxic algal blooms, excessive phytoplankton growth, low or no dissolved oxygen in bottom waters, and reduced sunlight causing losses in submerged aquatic vegetation critical for healthy estuarine ecosystems. Nitrogen oxides are a precursor to the formation of nitrate particulate matter (PM) in the atmosphere; this effect is most important in western areas.[3] NO_2 and airborne nitrate also contribute to pollutant haze, which impairs visibility and can reduce residential property values and revenues from tourism.

VOCs are a principal component in the chemical and physical atmospheric reactions that form O_3 and other photochemical oxidants. The reactivity of O_3 causes health problems because it damages biological tissues and cells. O_3 is also responsible each year for agricultural crop yield loss in the United States of several billion dollars and causes noticeable foliar damage in many crops and species of trees. Forest and ecosystem studies show that damage is resulting from current ambient O_3 levels plus excess nutrient enrichment and, in certain high-elevation areas, acidification.[3]

SO_2 is a precursor to the formation of sulfate PM, including acid and nonacid aerosols, in the atmosphere. Sulfate aerosols make up the largest single component of fine particulate matter in most locations in the eastern United States.[4] The major health effects of concern associated with exposures to high concentrations of SO_2, sulfate aerosols, and PM, include effects on breathing, respiratory illness and symptoms, alterations in the lung's defenses, aggravation of existing respiratory and cardiovascular disease, and mortality. Children and the elderly may be particularly sensitive. Also, SO_2 can produce foliar damage on trees and agricultural crops.

Together NO_x and SO_2 are the major precursors to acidic deposition (acid rain), which is associated with several environmental and human health effects. These effects include acidification of lakes and streams, impacts on forest soils, accelerated corrosion of buildings and monuments, and visibility impairment plus respiratory effects on humans associated with fine sulfate and nitrate particles.

Based on studies of human populations exposed to ambient particle pollution (sometimes in the presence of SO_2), and laboratory studies of animals and humans, the major effects of concern for human health include effects on breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissue, carcinogenesis, and premature mortality. Particulate matter causes damage to materials and soiling; it is a major cause of substantial visibility impairment in many parts of the United States.[4]

Fine particles ($PM_{2.5}$) are of health concern because they easily reach the deepest recesses of the lungs. Batteries of scientific studies have linked fine particles (alone or in combination with other air pollutants), with a series of significant health problems, including:

- Premature death
- Respiratory related hospital admissions and emergency room visits
- Aggravated asthma
- Acute respiratory symptoms, including aggravated coughing and difficult or painful breathing
- Chronic bronchitis
- Decreased lung function that can be experienced as shortness of breath
- Work and school absences[5]

Exposure to Pb can occur through multiple pathways, including inhalation of air, diet and ingestion of Pb in food, water, soil, or dust. Pb accumulates in the body in blood, bone, and soft tissue. Because it is not readily excreted, Pb also affects the kidneys, liver, nervous system, and blood-forming organs. Excessive exposure to Pb may cause neurological impairments such as seizures, mental retardation and/or behavioral disorders. Even at low doses, Pb exposure is associated with changes in fundamental enzymatic, energy transfer and homeostatic mechanisms in the body. Fetuses, infants, and children are especially susceptible to low doses of Pb, often suffering central nervous system damage. Recent studies have also shown that Pb may be a factor in high blood pressure and subsequent heart disease in middle-aged Caucasian males.[6]

NH_3, in the presence of water in the atmosphere reacts with sulfates and nitrates to create ammonium sulfate and ammonium nitrate, both of which are particles. Particles formed via chemical reactions in the atmosphere are known as secondarily formed particles and play an important role in the overall $PM_{2.5}$ particle budget.

1.3 WHAT ENHANCEMENTS HAVE BEEN MADE TO THE REPORT?

Since 1973, EPA has prepared estimates of annual national emissions in order to assess historic trends in criteria pollutant emissions. While these .estimates were prepared using consistent methodologies and were useful for evaluating emission changes from year to year, they did not provide an absolute indication of emissions for any given year. Beginning with the 1993 Emission Trends Report (containing data through 1992), EPA established a goal of preparing emission trends that would also incorporate the best available annual estimates of emissions.[a]

The EPA's Emission Factor and Inventory Group (EFIG) has developed procedures and criteria for replacing *Trends* data with emissions data submitted by States as part of a variety of ongoing programs (such as O_3 State Implementation Plan [SIP] submitted data). This report contains data obtained from several States through the 1996 periodic emission inventory (PEI) data submittals. Information related to how these data were incorporated into the National Emission Trends (NET) data base is given in Chapter 5.

The EFIG is also developing a data management and reporting system for emissions data. When the system is complete, the EFIG can extract the most current State inventories of emissions and supplement the gaps with EPA-generated attainment area emission inventories. The EFIG has already made several changes to the *Trends* methodology to make the transition smoother.

In this report, there are five distinct time periods: 1900 to 1939, 1940 to 1984, 1985 to 1989, 1990 to 1996, and 1996 forward. Since the accuracy and availability of historical data is limited, we have not generally made revisions to estimates before 1984 (with some exceptions, discussed in Chapter 5). However, many changes in current year totals have been incorporated into the reported estimates using State data.

Please note that methodologies within a given time period (especially more recent periods) will also *vary, as we include more accurate data in the **Trends** data base.*

Although there are many changes to the *Trends* methodology, some aspects have remained constant. For example, the 1900 through 1939 NO_x, VOC, and SO_2 estimates are extracted from the National Acid Precipitation Assessment Program (NAPAP) historical emissions report.[7,8] In addition, Pb estimates (1970 to present), and all CO, NO_x, VOC, SO_2, and PM_{10} estimates from 1940 to 1984 reported in *Trends* are based upon the previous national "top-down" methodology. Continuous emission monitoring (CEM) data reported by electric utilities to the Acid Rain Program's Emission Tracking System (ETS) were used, whenever available and complete, for NO_x, SO_2, and heat input values for the years 1996 and 1997. (These data apply to steam generated fossil-fuel units with nameplate capacity of at least 25 megawatts [MW].) These are some of the most accurate data collected by EPA because they represent actual monitored, instead of estimated, emissions.[5]

As has been stated in the past several Emission Trends Reports, EPA plans to incorporate as much State-derived data as possible into the Trends estimates. This report reflects the use of State data, specifically those data submitted by various States as part of the 1996 PEI reporting effort.

When data were not available, were deemed inappropriate for use in presenting emission Trends, or when EPA felt that we had a more robust mechanism for estimating emissions from a particular source sector, EPA relied on nationally derived estimates. We describe changes made to estimation techniques for this year in Chapter 5 of this report. Methods used for other source categories that we did not change for this year's report are detailed in the National Air Pollutant Emission Trends, Procedures Document, 1900-1996.[9] In general we updated the 1996 inventory with State data and then projected estimates for 1997 and 1998 based on economic or other types of growth indicators (such as the State Energy Data System (SEDS) fuel consumption estimates) to develop estimates for 1997 and 1998. We also applied reductions resulting from the Clean Air Act Amendments of 1990 (CAAA) to the 1997 and 1998 estimates. Throughout the report we have indicated when the changes in emissions are due mainly to methodological changes.

We have made two other significant enhancements to the report. First, the discussions of emission estimates and emission trends are oriented around types of sources rather than around pollutants. EPA has found that in questions related to emissions and emission trends, most requesters want information related to how much of a pollutant is emitted by a particular source, rather than the total emissions of a pollutant no matter the source. While there are still sections that discuss overall emissions by pollutant, there are larger sections of the report that we have oriented around the following five categories:

- combustion;
- industrial;
- on-road;
- non-road; and
- miscellaneous.

In particular, these five broader categories are used to provide additional clarity for information presented graphically. When these broader categories are used, they represent emissions from the following Tier categories (see section 1.4 and Table 1-1 for Tier category descriptions):

Category	Tier 1 Categories Included
Combustion	1, 2 and 3
Industrial	4, 5, 6, 7, 8, 9, and 10
On-road	11
Non-road	12
Miscellaneous	13 and 14

Some figures also show an "all other" category. The all other category represents the sum of all other Tier category emissions that are not specifically shown in the figure.

The second major change in the document is the usage of "plain language." In June 1998, President Clinton issued a memorandum instructing all government agencies to use plain language in new documents developed after October 1, 1998. Plain language is designed to produce documents that have logical organization, easy-to-read design features, and use common, everyday words (except necessary technical terms), "you" and other pronouns, the active voice (where possible), and short sentences (where possible). More information about the plain language initiative can be found at:

http://www.plainlanguage.gov/

1.4 HOW IS THE REPORT STRUCTURED?

Changes made in the format of the October 1995[10] report, intended to make the report more comprehensible and informative, within the framework of the plain language initiative, are maintained for this report. The executive summary presents a brief overview of each chapter of the report. In this introduction, Chapter 1, we inform the reader of changes to the report, the health effects of criteria air pollutants, and the structure of the report. A detailed account of the current year emissions by pollutant, source category, State, nonattainment area (NAA), county, and season and by a listing of top-emitting facilities is given in Chapter 2. National trends in emissions from 1900 (where available) to the current year and demographic, economic, and regulatory influences on emission trends are discussed in Chapter 3. Information on SO_2 emissions from industrial sources is presented in Chapter 4. An explanation of new methods of estimating pollutant emissions started during the past year is found in Chapter 5. Biogenic NO_x and VOC emissions are presented in Chapter 6. Emissions from sources, noncriteria pollutants, or countries not traditionally part of the *Trends* report are displayed in Chapters 7, 8, and 9. The EPA and other governmental agencies developed these emissions. In each chapter, numeric superscripts represent references and alphabetic superscripts represent endnotes.

As in last year's report, all emissions reported in tables and figures in the body of the report are in units of thousand short tons, except Pb.[b] The pollutants are presented in the order of CO, NO_x, VOC, SO_2, PM_{10}, $PM_{2.5}$, Pb, and NH_3 throughout this report. We developed emissions at the county and Source Classification Code (SCC) level for the years 1985 to 1998 for most source categories. We then summed these emissions to the national Tier level. There are four levels in the tier categorization. The first and second level, respectively called Tier 1 and Tier 2, are the same for each of the six criteria pollutants. [NOTE: Tier 2 in this context should not be confused with the recently announced Tier II motor vehicle control standards] The third level, Tier 3, is unique for each pollutant. The fourth level, Tier 4, is the SCC level. The match-up between SCC and all three tier levels can be obtained by contacting EFIG (see Note at the bottom of Table 1-1). Table 1-1 lists the Tier 1 and Tier 2 categories used in Chapters 1 through 5 to present the criteria air pollutant emission estimates. Tables and figures appear at the end of each chapter in the order in which we have discussed them within the chapter. Appendix A contains tables listing emissions for each of the criteria pollutants by Tier 3 source categories. If emissions are reported as zero, the emissions are less than 0.5 thousand tons (or 0.5 tons for Pb). "NA" indicates that the apportionment of the historic emissions to these subcategories is not possible. If a tier category does not appear, then emissions are not currently estimated for that category (either EPA estimates the emissions as zero or does not currently estimate the emissions due to time or resource limitations).

Throughout this report, emission estimates of PM_{10} and $PM_{2.5}$ are presented by source category as total from all sources, including fugitive dust sources, and nonfugitive dust sources. Fugitive dust sources are included in the following tier categories.

Tier 1	Tier 1 Name	Tier 2	Tier 2 Name
13	Natural Sources	02	Geogenic (wind erosion)
14	Miscellaneous	01	Agriculture and Forestry (agricultural crops or tilling and feedlots)
		07	Fugitive Dust (paved and unpaved roads; unpaved airstrips; construction; mining and quarrying; wind erosion - industrial; point source - haul roads)

Emissions of NO_x are expressed as weight-equivalent NO_2. Thus, we have inflated the actual tons of NO emitted to report them as if they were NO_2. You should therefore assume that the molecular weight was that of NO_2 when using numbers in this report.[c]

We report the VOC emissions as the actual weight of many different compounds. The relative amounts of the individual compounds emitted will determine the average molecular weight of a given source category's emissions. Therefore, no equivalent molecular weight standard exists for VOC. The VOC emissions referred to in this report exclude those organic compounds considered negligibly photochemically reactive, according to the EPA definition of VOC in the Code of Federal Regulations (40CFR51.100).[11] Thus, we have not included methane, ethane, and certain other organic compounds in the VOC totals.

1.5 REFERENCES

1. "Air Quality Criteria for Carbon Monoxide," EPA/600/8-90/045F (NTIS PB93-167492), Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
2. "Air Quality Criteria for Oxides of Nitrogen," EPA/600/8-91/049aF-cF.3v, Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1993.
3. "Air Quality Criteria for Ozone and Other Photochemical Oxidants," Volume I of III, EPA/600/8-93/004aF, Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1996.
4. "Air Quality Criteria for Particulate Matter and Sulfur Oxides," EPA/600/8-82/029aF-cF.3v (NTIS PB84-156777). Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
5. "Health and Environmental Effects of Particulate Matter," Fact Sheet, Office of Air and Radiation, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. July 17, 1997.
6. "Air Quality Criteria for Lead," EPA/600/8-83/028aF-dF.4v (NTIS PB87-142378), Office of Health and Environment Assessment, Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1991.
7. "Historic Emissions of Sulfur and Nitrogen Oxides in the United States from 1900 to 1980," EPA-600/7-85-009a and b, U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1985.
8. "Historic Emissions of Volatile Organic Compounds in the United States from 1900 to 1985," EPA-600/7-88-008a, U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1988.
9. "National Air Pollutant Emission Trends Procedures Document, 1900-1996," EPA-454/R-98-008, U.S. Environmental Protection Agency. May 1998.
10. "National Air Pollutant Emissions Trends, 1900-1994," EPA-454/R-95-011, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1995.
11. *Code of Federal Regulations*, Title 40, Volume 2, Parts 50 and 51 (40CFR51.100), pages 131-136, U.S. Government Printing Office. Revised July 1, 1999.

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[a] The great majority of all emission data necessarily are estimates. Exhaustive, on-site quantification, source by source, is a practical, and an economic, impossibility.

[b] Lead emissions are measured in short tons. Short tons can be converted to metric tons by dividing the emissions by a factor of 1.1023.

[c] The term nitrogen oxides (NO_x) encompasses emissions of both nitrogen dioxide (NO_2) and nitric oxide (NO).

Table 1-1. Major Source Categories

Tier 1 CODE*	Tier 1 NAME	Tier 2 CODE	Tier 2 NAME
01	*FUEL COMBUSTION-ELECTRIC UTILITIES*		
		01	Coal
		02	Oil
		03	Gas
		04	Other External Combustion
		05	Internal Combustion
02	*FUEL COMBUSTION-INDUSTRIAL*		
		01	Coal
		02	Oil
		03	Gas
		04	Other External Combustion
		05	Internal Combustion
03	*FUEL COMBUSTION-OTHER*		
		01	Commercial / Institutional Coal
		02	Commercial / Institutional Oil
		03	Commercial / Institutional Gas
		04	Misc. Fuel Combustion (except residential)
		05	Residential Wood
		06	Residential Other
04	*CHEMICAL & ALLIED PRODUCT MFG.*		
		01	Organic Chemical Mfg.
		02	Inorganic Chemical Mfg.
		03	Polymer & Resin Mfg.
		04	Agricultural Chemical Mfg.
		05	Paint, Varnish, Lacquer, Enamel Mfg.
		06	Pharmaceutical Mfg.
		07	Other Chemical Mfg.
05	*METALS PROCESSING*		
		01	Nonferrous
		02	Ferrous
		03	Metals Processing (not elsewhere classified [NEC])
06	*PETROLEUM & RELATED INDUSTRIES*		
		01	Oil & Gas Production
		02	Petroleum Refineries & Related Industries
		03	Asphalt Manufacturing
07	*OTHER INDUSTRIAL PROCESSES*		
		01	Agriculture, Food, & Kindred Products
		02	Textiles, Leather, & Apparel Products
		03	Wood, Pulp & Paper, & Publishing Products
		04	Rubber & Miscellaneous Plastic Products
		05	Mineral Products
		06	Machinery Products
		07	Electronic Equipment
		08	Transportation Equipment
		09	Construction
		10	Miscellaneous Industrial Processes
08	*SOLVENT UTILIZATION*		
		01	Degreasing
		02	Graphic Arts
		03	Dry Cleaning
		04	Surface Coating
		05	Other Industrial
		06	Nonindustrial
		07	Solvent Utilization (NEC)
09	*STORAGE & TRANSPORT*		
		01	Bulk Terminals & Plants
		02	Petroleum & Petroleum Product Storage
		03	Petroleum & Petroleum Product Transport
		04	Service Stations: Stage I
		05	Service Stations: Stage II
		06	Service Stations: Breathing & Emptying
		07	Organic Chemical Storage
		08	Organic Chemical Transport
		09	Inorganic Chemical Storage
		10	Inorganic Chemical Transport
		11	Bulk Materials Storage
		12	Bulk Materials Transport
10	*WASTE DISPOSAL & RECYCLING*		
		01	Incineration
		02	Open Burning
		03	Publicly Owned Treatment Works
		04	Industrial Waste Water
		05	Treatment Storage and Disposal Facility
		06	Landfills
		07	Other
11	*ON-ROAD VEHICLES*		
		01	Light-Duty Gasoline Vehicles & Motorcycles
		02	Light-Duty Gasoline Trucks
		03	Heavy-Duty Gasoline Vehicles
		04	Diesels
12	*NON-ROAD ENGINES AND VESSELS*		
		01	Non-road Gasoline Engines
		02	Non-road Diesel Engines
		03	Aircraft
		04	Marine Vessels
		05	Railroads
13	*NATURAL SOURCES*		
		01	Biogenic
		02	Geogenic (wind erosion)
		03	Miscellaneous (lightning/freshwater/saltwater)
14	*MISCELLANEOUS*		
		01	Agriculture & Forestry
		02	Other Combustion (wildfires)
		03	Catastrophic / Accidental Releases
		04	Repair Shops
		05	Health Services
		06	Cooling Towers
		07	Fugitive Dust

Note(s): * Code numbers are presented for The Representative Emissions National Data System (TRENDS) user.
The Source Classification Code (SCC) definitions and assignment to Tier category are available on the Technology Transfer Network's (919-541-5742) Emission Inventories/Emission Factors Information (CHIEF) Technical Information Area, or on the Internet (**www.epa.gov/ttn/chief**).

Chapter 2.0 1998 Emissions

2.1 WHAT EMISSIONS DATA ARE PRESENTED IN THIS CHAPTER?

This chapter describes the carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compound (VOC), sulfur dioxide (SO_2), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), lead (Pb), and ammonia (NH_3) emission estimates for 1998. Any notable trends from 1996 levels are discussed.

2.2 HOW HAVE EMISSION ESTIMATES CHANGED FROM 1996 TO 1998 AND WHY?

Tables A-1 through A-7 provide detailed emission summaries for all pollutants at 5-year intervals from 1970 through 1985 and yearly for the period 1988 through 1998. Exact percentage changes from year to year for specific source categories can be calculated from those tables. In particular the tables show that between 1996 and 1998, overall emissions levels for CO and VOC decreased, NO_x remained essentially level, while emissions for SO_2, PM_{10}, and $PM_{2.5}$, and Pb increased. Specifically,

...for utilities

- SO_2 emissions from point sources increased primarily due to coal-fired and oil-fired electric utilities. Increased burning of bituminous and anthracite coal by utilities created an increase of approximately 0.5 million tons/year of SO_2.[1]

...for on-road vehicles

- Reductions due to fleet turnover (implementation of Tier I standards),[2] reformulated gasoline requirements, oxygenated fuel, and fuels with lower Reid vapor pressure resulted in the decrease in on-road CO, NO_x, VOC, PM_{10}, and $PM_{2.5}$ emissions despite the higher vehicle miles traveled (VMT) in 1998.

- Higher VMT caused an increase in SO_2 and NH_3 on-road emissions.

- Changes to 1990-1998 NO_x emissions from heavy-duty diesel vehicles (HDDV) due to adjustments in emissions due to the diesel defeat device (see section 5.7.4).

...for non-road vehicles

- 1998 emissions decreased slightly for CO, NO_x, and VOC, remained steady for Pb, and increased slightly for NO_x, SO_2, PM_{10}, and $PM_{2.5}$ due to variations in fuel consumption by non-road engines[3] (gasoline and diesel) and vehicles (airplanes, locomotives, and marine vessels).

...for miscellaneous sources

- 1998 miscellaneous emissions decreased from 1996 levels for all pollutants except PM_{10}, $PM_{2.5}$, and NH_3. Increases in particulate emissions were primarily the result of increased VMT on paved and unpaved roads, as well as growth in the construction sector due to the strong economy. Increases in NH_3 were primarily an inventory artifact resulting from improved activity data related to agricultural livestock operations.[4]

2.2.1 What Sources Are the Main Contributors to 1998 CO Emissions?

Figure 2-1 is a pie chart showing 1998 CO emissions by source category. As the figure shows:

- On-road vehicles are major contributors to CO emissions, representing 57 percent of total national CO emissions. Of this 57 percent, just over half comes from light-duty gasoline vehicles (LDGVs [primarily cars]) and motorcycles.

- Non-road vehicles and engines contribute slightly more than 20 percent of total CO emissions. These emissions come primarily from gasoline consumption by lawn and garden, industrial, and recreational marine engines.

- Solvent utilization, storage and transport, and electric utility fuel combustion (three Tier 1 source categories) contribute slightly more than 0.5 percent to total national CO emissions. These source categories are combined with petroleum and related industries, industrial fuel combustion, other industrial processes, waste disposal and recycling, and chemical and allied product manufacturing, to create the "all other" grouping in Figure 2-1.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources and some minor point sources, comprise over 95 percent of total 1998 CO emissions.

2.2.2 What Sources Are the Main Contributors to 1998 NO_x Emissions?

Figure 2-2 is a pie chart showing 1998 NO_x emissions by source category. As the figure shows:

- On-road vehicles account for 31 percent of total national NO_x emissions. LDGVs are a major contributor (approximately 37 percent) to the 1998 on-road vehicle NO_x emissions.

- Electric utilities represent 25 percent of total national NO_x emissions in 1998. Coal combustion represents almost 90 percent of these emissions, with two-thirds of the coal combustion emissions coming from bituminous coal combustion.

- Solvent utilization, storage and transport, waste disposal and recycling, and metals processing (four Tier 1 source categories) constitute less that 1 percent of total national NO_x emissions. The United States (U.S.) Environmental Protection Agency (EPA) includes these sources in the "all other" grouping in Figure 2-2, along with chemical and allied product manufacturing, other industrial processes, miscellaneous, and petroleum and related industries.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources, comprise 62 percent of total 1998 NO_x emissions. On-road and non-road sources contribute 53 percent of the total NO_x.

2.2.3 What Sources Are the Main Contributors to 1998 VOC Emissions?

Figure 2-3 shows 1998 VOC emissions by source category. As the figure indicates:

- Solvent utilization represents 30 percent of the total 1998 VOC emissions. Surface coating constitutes just over 40 percent of the solvent utilization emissions. The 26 specific subcategories of surface coating estimated by EPA are presented in Table A-3. Table A-3 also shows the effects of control programs on these sources. For example, co-control of VOCs related to maximum achievable control technology (MACT) controls can be seen for 1998 emissions from industrial adhesive surface coating operations. A MACT standard for that source category went into effect in 1998, reducing emissions by over 50 percent relative to 1996 and 1997 values.[5]

- On-road vehicles represented 29 percent of total national VOC emissions. LDGVs account for just over half of total national on-road vehicle VOC emissions.

- Electric utility fuel combustion and metals processing (two Tier 1 source categories) contribute slightly less than 3 percent of total national VOC emissions. EPA combines electric utility fuel combustion, metals processing, chemical and allied product manufacturing, petroleum and related industries, miscellaneous, other industrial processes and fuel combustion (industrial, other) into an "all other" grouping of Figure 2-3. This "all other" grouping contributed 21 percent to the total 1998 VOC emissions.

Table 2-1 presents the point and area source split of the Tier 1 source categories. Area source emissions, including transportation sources, make up 86 percent of total 1998 VOC emissions.

2.2.4 What Sources Are the Main Contributors to 1998 SO_2 Emissions?

Figure 2-4 is a pie chart showing 1998 SO_2 emissions by source category. As the figure shows:

- Electric utilities contribute the majority of SO_2 emissions, representing over two-thirds (68 percent) of total national SO_2 emissions in 1998. Well over 90 percent of these emissions come from coal combustion. Bituminous coal combustion accounts three-fourths of the electric utility coal combustion emissions.

- Industrial coal combustion produced 15 percent of the 1998 SO_2 emissions.

- Solvent utilization, storage and transport, waste disposal and recycling, on-road sources, and miscellaneous (five Tier 1 source categories) account for 2 percent of total national SO_2 emissions. These sources, along with non-road sources, petroleum and related industries, and other industrial processes, comprise EPA's "all other" grouping.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources, make up 14 percent of total 1998 SO_2 emissions, while point sources make up the remainder.

2.2.5 What Sources Are the Main Contributors to 1998 Particulate Matter (PM_{10} and $PM_{2.5}$) Emissions?

Figures 2-5 and 2-6 are pie charts showing 1998 PM_{10} and $PM_{2.5}$ emissions by source category. They depict the nonfugitive dust sources of PM_{10} and $PM_{2.5}$. As the figures show:

- Fuel combustion processes (utilities, industrial, commercial, and institutional boilers, and area source combustion) contribute the most to the nonfugitive dust portions of PM. Mobile sources, both on-road and non-road, are the next largest category of emitters. Industrial processes collectively comprise only about 10 percent of the nonfugitive dust sources, but they could have a significant effect on air quality in their vicinity.

- Wildfire PM_{10} and $PM_{2.5}$ emissions for 1998 decreased significantly relative to 1996 and 1997 levels due to a dramatic reduction in the number of acres burned. Managed burning and wildfires comprise most of the area source combustion contributions in Figures 2-5 and 2-6.

Although the NET inventory shows that fugitive dust contributes a large percentage to the total PM emissions, a report by the Desert Research Institute found that about 75% of these emissions are within 2 m of the ground at the point they are measured. Thus, most of them are likely to be removed or deposited within a few km of their release, depending on atmospheric turbulence, temperature, soil moisture, availability of horizontal and vertical surfaces for impaction and initial suspension energy. This is consistent with the generally small amount of crustal materials found on speciated ambient samples.[6]

For a complete understanding of $PM_{2.5}$ emissions, one should also consider the emissions of SO_2, NO_x, and NH_3. These gases react in the atmosphere to form ammonium sulfate and ammonium nitrate fine particles; also, some organic particles are formed from VOCs. These "secondary" fine particles (in contrast to the directly emitted particles from combustion and fugitive dust) can comprise as much as half the $PM_{2.5}$ measured in the U.S.[7] Source apportionment studies exist to help elucidate the role of primary PM (reflected in the NET) and secondary PM.

Table 2-1 presents the point and area split of the Tier 1 source categories. Area source emissions, including transportation sources, make up 96 percent of total 1998 PM_{10} emissions. Methods and related data sources for several area source categories are currently being reviewed. These include unpaved roads, open burning, and construction.

Note that some emission estimates have not been updated. For example, wind erosion particulate emissions have been maintained at a constant value since 1996. Also, annual estimates of wind erosion emissions are difficult to interpret, owing to the extremely short duration of most wind events.

2.2.6 What Sources Are the Main Contributors to 1998 Pb Emissions?

Figure 2-7 is a pie chart showing 1998 Pb emissions by source category. As the figure shows:

- Metals processing contributes 53 percent to total national Pb emissions. Nonferrous metal processing represents 65 percent of the 1998 metals processing emissions. Primary and secondary Pb products represent 46 and 37 percent, respectively, of the nonferrous metals in 1998.

- On-road emissions account for less than 0.5 percent of total national Pb emissions.

- EPA does not estimate Pb emissions for the following 5 Tier 1 source categories because Pb emissions from these sources are thought to be negligible: solvent utilization, storage and transport, petroleum and related industries, natural sources, and miscellaneous. Figure 2-7 shows the percentage contribution from the remaining 9 Tier 1 categories. The "all other" grouping includes chemical and allied product manufacturing, other industrial processes, and fuel combustion (electric utility and industrial).

2.2.7 What Sources Are the Main Contributors to 1998 NH_3 Emissions?

Figure 2-8 is a pie chart showing 1998 NH_3 emissions by source category. As the figure shows, livestock agriculture contributes the largest amount of NH_3 emissions. Livestock agriculture and fertilizer application combined comprise 86 percent of total national NH_3 emissions in 1998. Currently, the USDA and EPA are working to refine the NH_3 inventory for all source categories, including some natural and biogenic categories that are not in the current inventory. As mentioned above (section 2.2.5), NH_3 is involved in the formation of ammonium sulfate and ammonium nitrate particles. The NH_3 inventory is important to perform modeling simulations to understand the formation of these particles in the atmosphere using transport and transformation models.

2.3 HOW DOES EPA ESTIMATE AND REPORT SPATIAL EMISSIONS?

EPA estimates emissions at the county level and then sums them to the state level for all criteria pollutants except Pb and for all source categories except fugitive dust sources and wildfires (whose emissions are estimated at the State level and are allocated to the county level using spatial surrogates). Figures 2-9 through 2-15 present the broad geographic distributions of 1998 emissions based on each county's tonnage per square mile. Specifically,

- Figure 2-9 shows that (on an emission density basis) the eastern third of the United States and the west coast emit more CO than the western two-thirds of the continental United States.
- Figures 2-10 through 2-12 show that the eastern half of the United States and the west coast emit more NO_x, VOC, and SO_2 than the western half of the continental United States.
- Fugitive dust emissions, which predominate in rural and agricultural areas, comprise the major component of PM_{10} and $PM_{2.5}$ emissions. NH_3 emissions follow a similar pattern, although they are primarily associated with agricultural and fertilizer sources rather than fugitive dust.

2.3.1 How Does My State Compare in Rank to Other States?

To understand how a particular State ranks relative to magnitude of emissions, refer to Table 2-2, which presents the total state-level emissions and state rankings for all pollutants.

- EPA summed the county-level emissions to produce the state-level emissions.
- The estimates for Alaska and Hawaii include only on-road vehicle, point source, residential wood combustion, and wildfire emissions. PM_{10} and $PM_{2.5}$ estimates also include some fugitive dust estimates for Alaska and Hawaii. (A base year inventory similar to National Acid Precipitation Assessment Program (NAPAP) was not available for these states.)

2.4 WHAT ARE THE LARGEST POINT SOURCES IN THE INVENTORY?

Refer to Table 2-1 to understand which categories contain the largest amount of point sources. Historically, steel mills, smelters, utility plants, and petroleum refining produce the largest point source emissions. We usually provide point source top 50 lists in this report; however, this year new periodic emission inventory (PEI) point source data was received and was still being quality assured at press time. Once the State data is deemed accurate, EPA intends to post top 50 lists by pollutant on EPA's Emission Factor and Inventory Group's (EFIG) web site (expected later in 2000). The internet address for the EFIG is: **http://www.epa.gov/ttn/chief/efig**.

2.5 REFERENCES

1. **http://www.epa.gov/acidrain/cems/cemlng.html**
2. Federal Register as 56 FR 25724, June 5, 1991.
3. **http://www.epa.gov/otaq/nonrdmdl.htm**
4. 1997 Census of Agriculture: Geographic Area Series, Volume 1, 1A, 1B, 1C [machine-readable data file] / United States Dept. of Agriculture, National Agricultural Statistics Service. Washington, D.C.: The Service [producer and distributor], 1999.
5. Listing of MACT rules may be found at: **http://www.epa.gov/ttn/uatw/eparules.html**
6. Watson, John G. and Judith C. Chow, "Reconciling Urban Fugitive Dust Emissions Inventory and Ambient Source Contribution Estimates: Summary of Current Knowledge and Recent Research" DRAFT, Desert Research Institute Document No. 61104dD2, Reno, NV, September 3, 1999. (This document may be found at: **http//www.epa.gov/ttn/chief/ap42pdf/fugitive.pdf**).
7. "National Air Quality and Emission Trends Report, 1997", EPA-454/R-98-016, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Pages 42-45, December 1998.
8. "National Air Pollutant Emissions Trends, 1900-1996," EPA-454/R-97-011, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1997.
9. Bollman, A.D. and G. Stella, "Status and Future Plans for the Economic Growth Analysis System (EGAS)." Proceedings of the Air & Waste Management Association Emission Inventory Specialty Conference, New Orleans, LA, December 8-10, 1998.

Table 2-1. 1998 National Point and Area Emissions by Source Category and Pollutant (thousand short tons)

	CO			NO_x			VOC			SO_2		
Source Category	Point	Area	Total	Point	Area	Total	Point	Area	Total	Point	Area	Total
FUEL COMB. ELEC. UTIL.	413	4	417	6,095	8	6,103	54	0	54	13,217	0	13,217
FUEL COMB. INDUSTRIAL	908	206	1,114	2,142	827	2,969	144	17	161	2,075	820	2,895
FUEL COMB. OTHER	83	3,760	3,843	142	975	1,117	12	666	678	191	418	609
CHEMICAL & ALLIED PRODUCT MFG	1,129	0	1,129	152	0	152	312	84	396	299	0	299
METALS PROCESSING	1,494	1	1,495	88	0	88	75	0	76	444	0	444
PETROLEUM & RELATED INDUSTRIES	365	3	368	122	16	138	223	273	496	344	0	345
OTHER INDUSTRIAL PROCESSES	629	3	632	402	6	408	388	62	450	366	3	370
SOLVENT UTILIZATION	2	0	2	2	0	2	639	4,640	5,278	1	0	1
STORAGE & TRANSPORT	80	0	80	7	0	7	298	1,025	1,324	3	0	3
WASTE DISPOSAL & RECYCLING	31	1,123	1,154	38	59	97	27	406	433	19	24	42
HIGHWAY VEHICLES	0	50,386	50,386	0	7,765	7,765	0	5,325	5,325	0	326	326
OFF-HIGHWAY	0	19,914	19,914	0	5,280	5,280	0	2,461	2,461	0	1,084	1,084
NATURAL SOURCES	0	0	0	0	0	0	0	14	14	0	0	0
MISCELLANEOUS	0	8,920	8,920	1	327	328	2	770	772	0	12	12
TOTAL	5,134	84,319	89,454	9,190	15,264	24,454	2,174	15,743	17,917	16,960	2,688	19,647

Emissions (percent)

	CO			NO_x			VOC			SO_2		
Source Category	Point	Area	Total	Point	Area	Total	Point	Area	Total	Point	Area	Total
FUEL COMB. ELEC. UTIL.	8	0	0	66	0	25	2	0	0	78	0	67
FUEL COMB. INDUSTRIAL	18	0	1	23	5	12	6	0	1	12	31	15
FUEL COMB. OTHER	2	4	4	2	6	5	0	4	4	1	16	3
CHEMICAL & ALLIED PRODUCT MFG	22	0	1	2	0	1	12	1	2	2	0	2
METALS PROCESSING	29	0	2	1	0	0	18	0	2	3	0	2
PETROLEUM & RELATED INDUSTRIES	7	0	0	1	0	1	9	2	3	2	0	2
OTHER INDUSTRIAL PROCESSES	12	0	1	4	0	2	15	0	2	2	0	2
SOLVENT UTILIZATION	0	0	0	0	0	0	25	29	29	0	0	0
STORAGE & TRANSPORT	2	0	0	0	0	0	12	7	7	0	0	0
WASTE DISPOSAL & RECYCLING	1	1	1	0	0	0	1	3	2	0	1	0
HIGHWAY VEHICLES	0	60	56	0	51	32	0	34	29	0	12	2
OFF-HIGHWAY	0	24	22	0	35	22	0	16	13	0	40	6
NATURAL SOURCES	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	0	11	10	0	2	1	0	5	4	0	0	0
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100

Table 2-1 (continued)

Source Category	PM_{10} Point	PM_{10} Area	PM_{10} Total	$PM_{2.5}$ Point	$PM_{2.5}$ Area	$PM_{2.5}$ Total	NH_3 Point	NH_3 Area	NH_3 Total
FUEL COMB. ELEC. UTIL.	302	0	302	165	0	165	8	0	8
FUEL COMB. INDUSTRIAL	201	45	245	147	13	160	40	7	47
FUEL COMB. OTHER	18	526	544	11	455	466	0	6	6
CHEMICAL & ALLIED PRODUCT MFG	65	0	65	39	0	39	165	0	165
METALS PROCESSING	170	0	171	112	0	112	5	0	5
PETROLEUM & RELATED INDUSTRIES	31	1	32	18	0	18	35	0	35
OTHER INDUSTRIAL PROCESSES	299	40	339	168	19	187	4	40	44
SOLVENT UTILIZATION	6	0	6	5	0	5	0	0	0
STORAGE & TRANSPORT	94	0	94	32	0	32	1	0	1
WASTE DISPOSAL & RECYCLING	13	297	310	9	230	238	0	86	86
HIGHWAY VEHICLES	0	257	257	0	197	197	0	250	250
OFF-HIGHWAY	0	461	461	0	413	413	0	10	10
NATURAL SOURCES	0	5,307	5,307	0	796	796	0	34	34
MISCELLANEOUS	34	26,576	26,609	22	5,527	5,549	0	4,244	4,244
TOTAL	**1,232**	**33,509**	**34,741**	**729**	**7,650**	**8,379**	**259**	**4,677**	**4,936**

Emissions (percent)

Source Category	PM_{10} Point	PM_{10} Area	PM_{10} Total	$PM_{2.5}$ Point	$PM_{2.5}$ Area	$PM_{2.5}$ Total	NH_3 Point	NH_3 Area	NH_3 Total
FUEL COMB. ELEC. UTIL.	25	0	1	23	0	2	3	0	0
FUEL COMB. INDUSTRIAL	16	0	1	20	0	2	16	0	1
FUEL COMB. OTHER	1	2	2	2	6	6	0	0	0
CHEMICAL & ALLIED PRODUCT MFG	5	0	0	5	0	0	64	0	3
METALS PROCESSING	14	0	0	15	0	1	2	0	0
PETROLEUM & RELATED INDUSTRIES	3	0	0	2	0	0	14	0	1
OTHER INDUSTRIAL PROCESSES	24	0	1	23	0	2	2	1	1
SOLVENT UTILIZATION	0	0	0	1	0	0	0	0	0
STORAGE & TRANSPORT	8	0	0	4	0	0	0	0	0
WASTE DISPOSAL & RECYCLING	1	1	1	1	3	3	0	2	2
HIGHWAY VEHICLES	0	1	1	0	3	2	0	5	5
OFF-HIGHWAY	0	1	1	0	5	5	0	0	0
NATURAL SOURCES	0	16	15	0	10	10	0	1	1
MISCELLANEOUS	3	79	77	3	72	66	0	91	86
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 2-2. Anthropogenic 1998 State-level Emissions and Rank for CO, NO_x, VOC, SO_2, PM_{10}, $PM_{2.5}$, and NH_3

(thousand short tons)

State	Rank	CO	Rank	NO_x	Rank	VOC	Rank	SO_2	Rank	PM_{10}	Rank	$PM_{2.5}$	Rank	NH_3
Alabama	12	2,361	15	619	16	419	9	764	19	619	15	184	24	88
Alaska	13	2,249	44	99	14	457	50	12	39	274	19	155	51	1
Arizona	27	1,370	23	450	26	281	26	225	36	336	24	145	36	35
Arkansas	31	1,147	35	267	32	223	36	125	23	529	25	132	10	161
California	1	8,072	2	1,456	2	1,215	28	182	3	1,973	3	535	7	211
Colorado	29	1,200	25	400	27	274	35	137	24	518	29	126	15	111
Connecticut	37	793	41	153	35	156	41	66	45	119	45	30	45	8
DC	51	100	51	23	51	22	51	11	51	6	51	2	50	2
Delaware	50	216	47	77	48	51	37	96	48	39	48	14	43	12
Florida	3	5,203	5	1,059	3	891	6	1,008	11	822	7	260	22	94
Georgia	4	3,998	12	730	9	576	13	660	7	1,103	4	320	17	106
Hawaii	47	321	48	59	47	53	47	35	49	35	49	11	47	7
Idaho	34	956	43	116	39	115	46	39	14	678	17	161	27	78
Illinois	9	2,890	4	1,076	6	748	4	1,153	9	1,028	6	261	11	148
Indiana	11	2,526	7	848	12	518	3	1,164	17	641	20	154	18	104
Iowa	33	1,045	30	343	31	239	23	283	20	602	27	130	2	305
Kansas	28	1,230	20	479	30	257	30	163	4	1,570	5	299	4	232
Kentucky	26	1,389	14	682	23	330	10	753	35	345	35	103	21	95
Louisiana	14	2,184	9	825	15	425	16	405	27	441	23	149	13	130
Maine	42	488	45	94	40	109	44	53	42	158	36	102	46	8
Maryland	32	1,107	29	344	33	183	19	339	41	227	42	57	38	28
Massachusetts	30	1,188	31	304	29	264	24	264	38	290	40	72	42	14
Michigan	7	3,309	6	880	4	765	14	628	21	569	21	153	29	70
Minnesota	22	1,552	21	476	19	381	31	162	10	1,011	10	222	8	198
Mississippi	25	1,414	28	353	24	304	21	305	26	458	26	130	23	91
Missouri	19	1,816	16	546	20	360	15	482	5	1,286	8	252	6	221
Montana	39	703	39	176	42	105	42	60	6	1,137	12	216	19	96
Nebraska	40	681	36	239	36	154	38	94	18	632	30	125	3	241
Nevada	41	520	40	157	43	98	40	66	44	143	44	39	40	17
New Hampshire	45	355	46	82	45	74	34	148	47	54	47	17	48	3
New Jersey	24	1,454	22	466	17	408	25	257	37	313	37	96	41	15
New Mexico	36	855	32	279	38	140	27	199	1	4,987	1	781	34	49
New York	6	3,327	13	723	5	753	12	688	12	767	11	222	30	69
North Carolina	10	2,773	11	745	8	605	11	729	25	501	16	172	9	183
North Dakota	43	380	37	235	41	105	20	327	29	430	38	92	26	79
Ohio	5	3,934	3	1,198	7	706	1	1,921	16	658	13	195	16	111
Oklahoma	23	1,518	24	440	25	295	32	157	8	1,033	14	193	5	222
Oregon	18	1,988	33	271	28	272	43	58	13	686	9	224	31	65
Pennsylvania	8	2,909	8	840	10	575	2	1,221	22	547	18	156	20	96
Rhode Island	49	221	50	35	49	49	49	12	50	25	50	8	49	2
South Carolina	20	1,638	26	367	22	334	22	290	30	410	34	112	37	33
South Dakota	46	333	42	119	44	78	45	53	34	349	39	73	12	132
Tennessee	16	2,037	10	761	11	528	7	789	33	375	28	130	25	83
Texas	2	5,644	1	2,140	1	1,388	5	1,096	2	3,655	2	733	1	511
Utah	35	942	38	233	34	161	39	79	40	238	41	69	35	36
Vermont	48	240	49	46	50	44	48	16	46	75	46	18	44	10
Virginia	15	2,149	17	532	13	471	18	373	31	409	32	118	28	73
Washington	17	2,035	27	364	21	347	33	155	28	430	22	149	32	59
West Virginia	38	721	18	500	37	141	8	787	43	152	43	50	39	19
Wisconsin	21	1,600	19	480	18	400	17	378	32	391	33	112	14	124
Wyoming	44	361	34	270	46	68	29	179	15	663	31	122	33	53
National		89,454		24,454		17,917		19,647		34,741		8,379		4,935

Note(s): The sums of States may not equal National totals due to rounding.

Figure 2-1. 1998 National CARBON MONOXIDE Emissions by Principal Source Categories

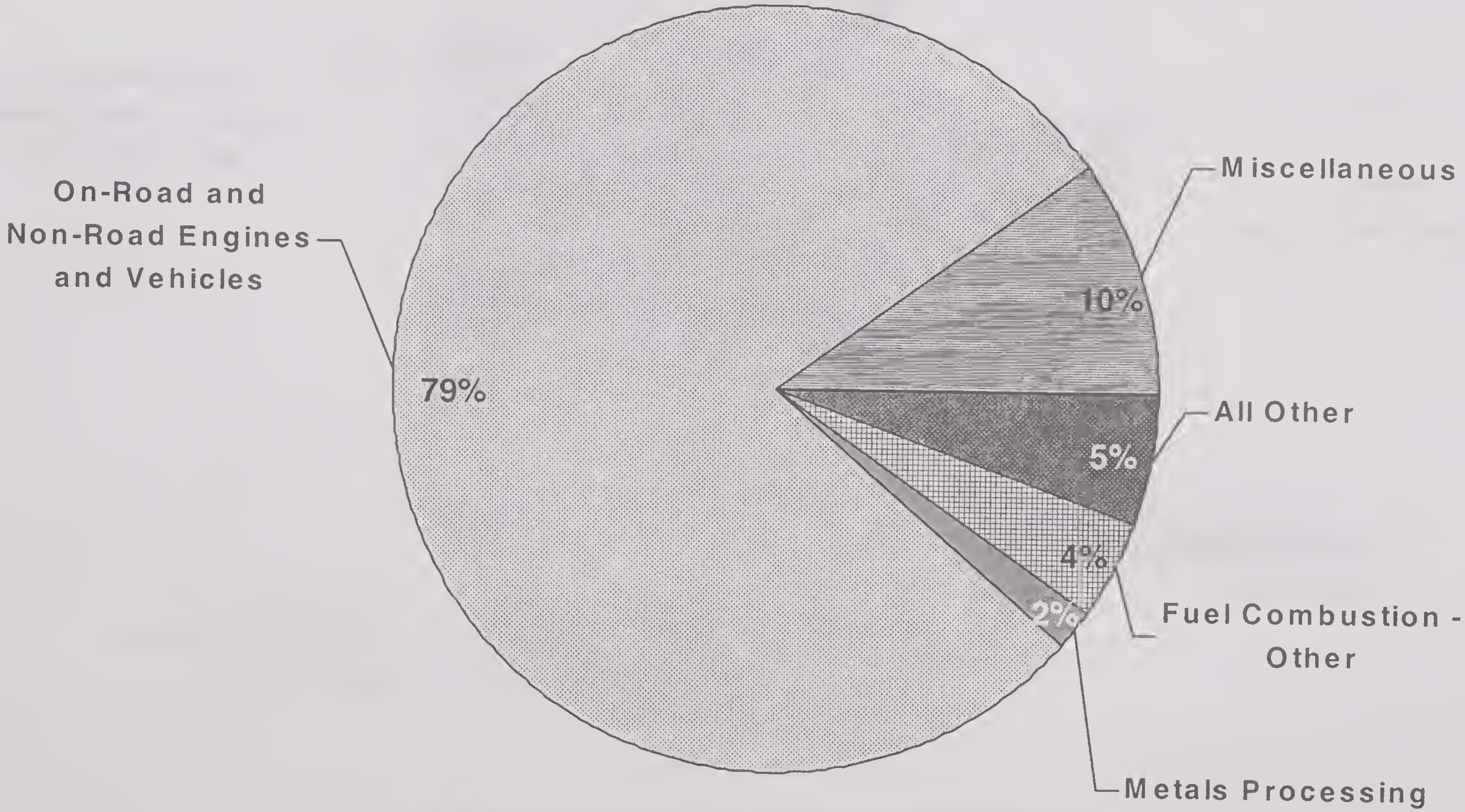


Figure 2-2. 1998 National NITROGEN OXIDE Emissions by Principal Source Categories

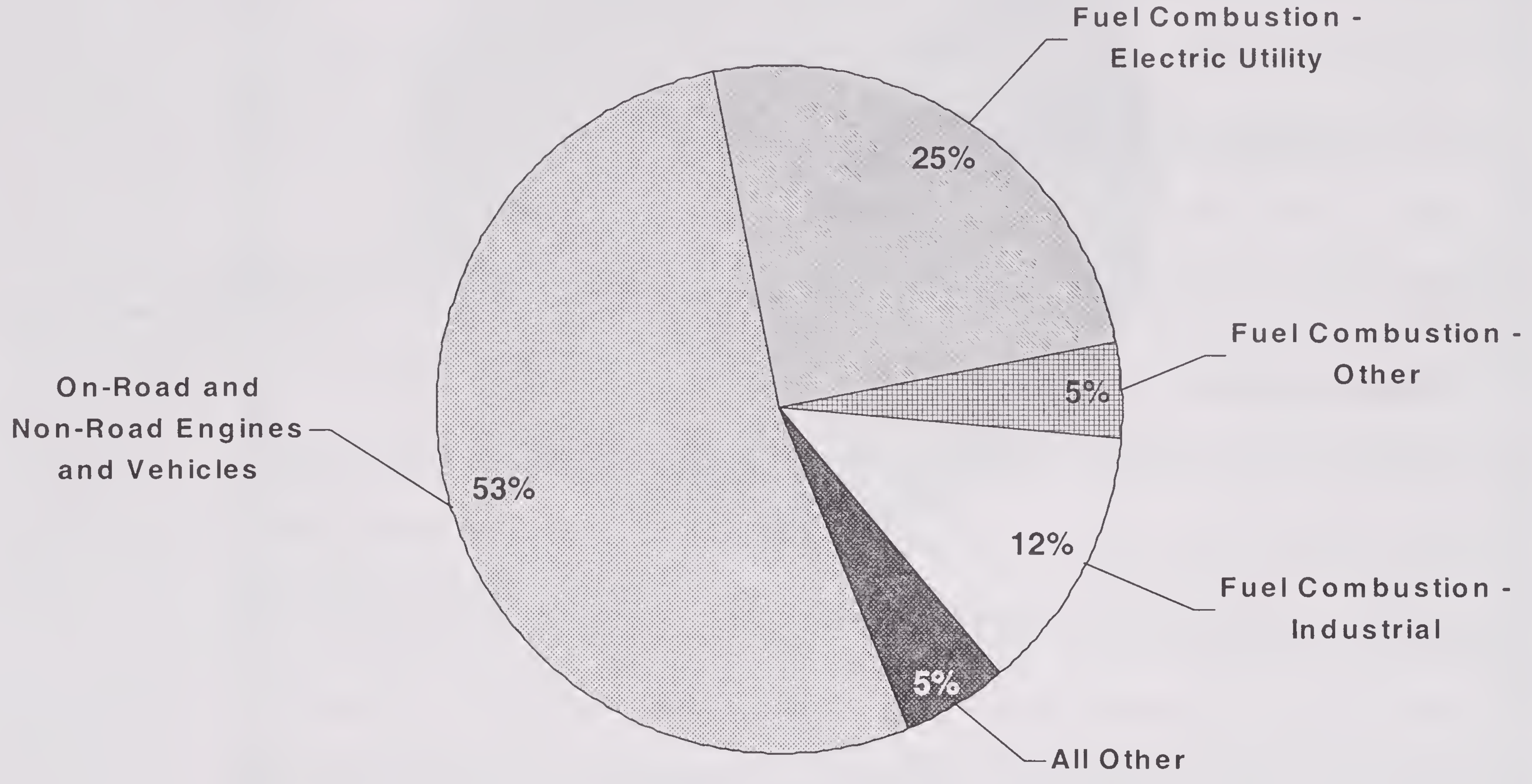


Figure 2-3. 1998 National VOLATILE ORGANIC COMPOUND Emissions by Principal Source Categories

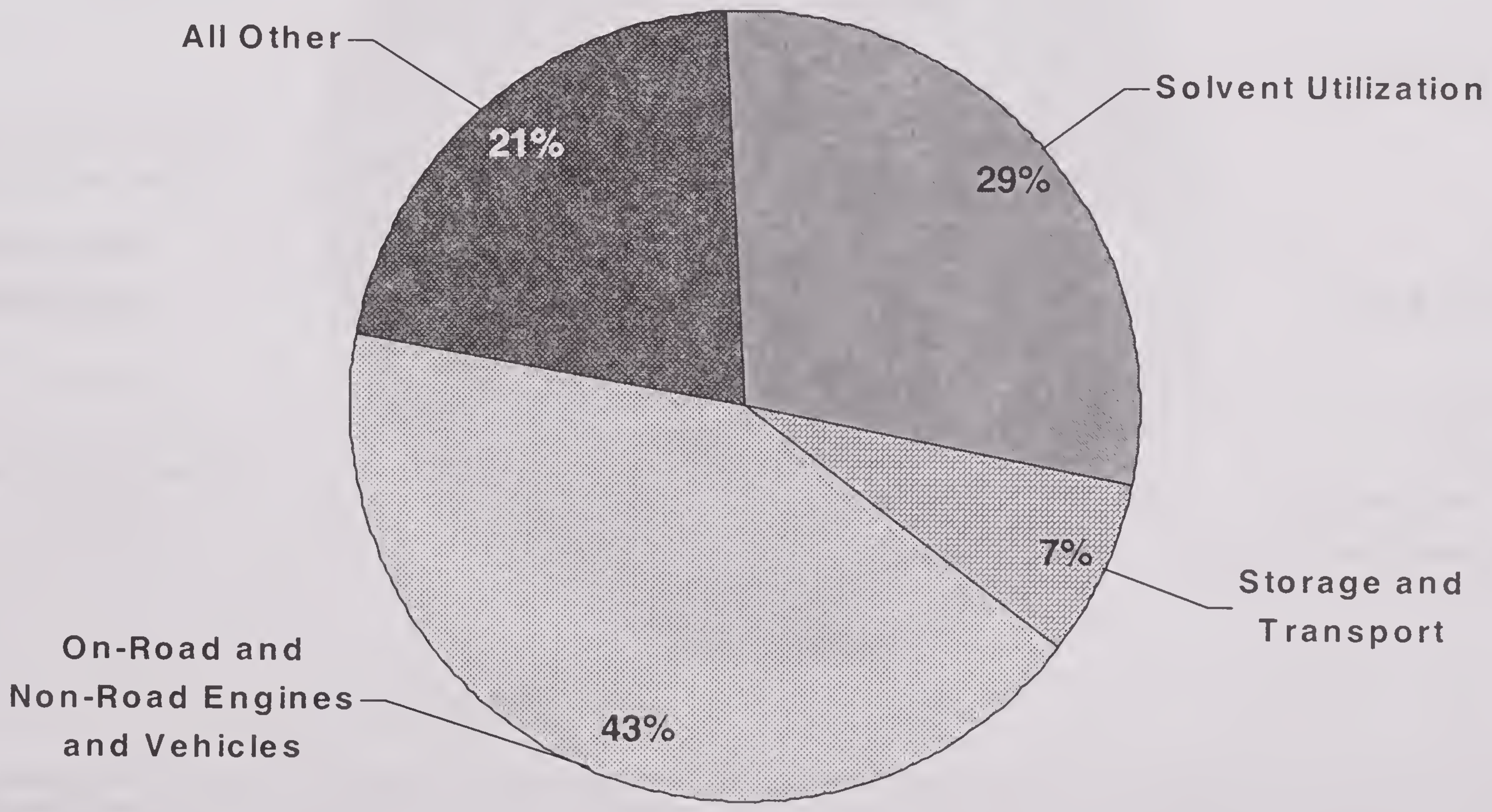


Figure 2-4. 1998 National SULFUR DIOXIDE Emissions by Principal Source Categories

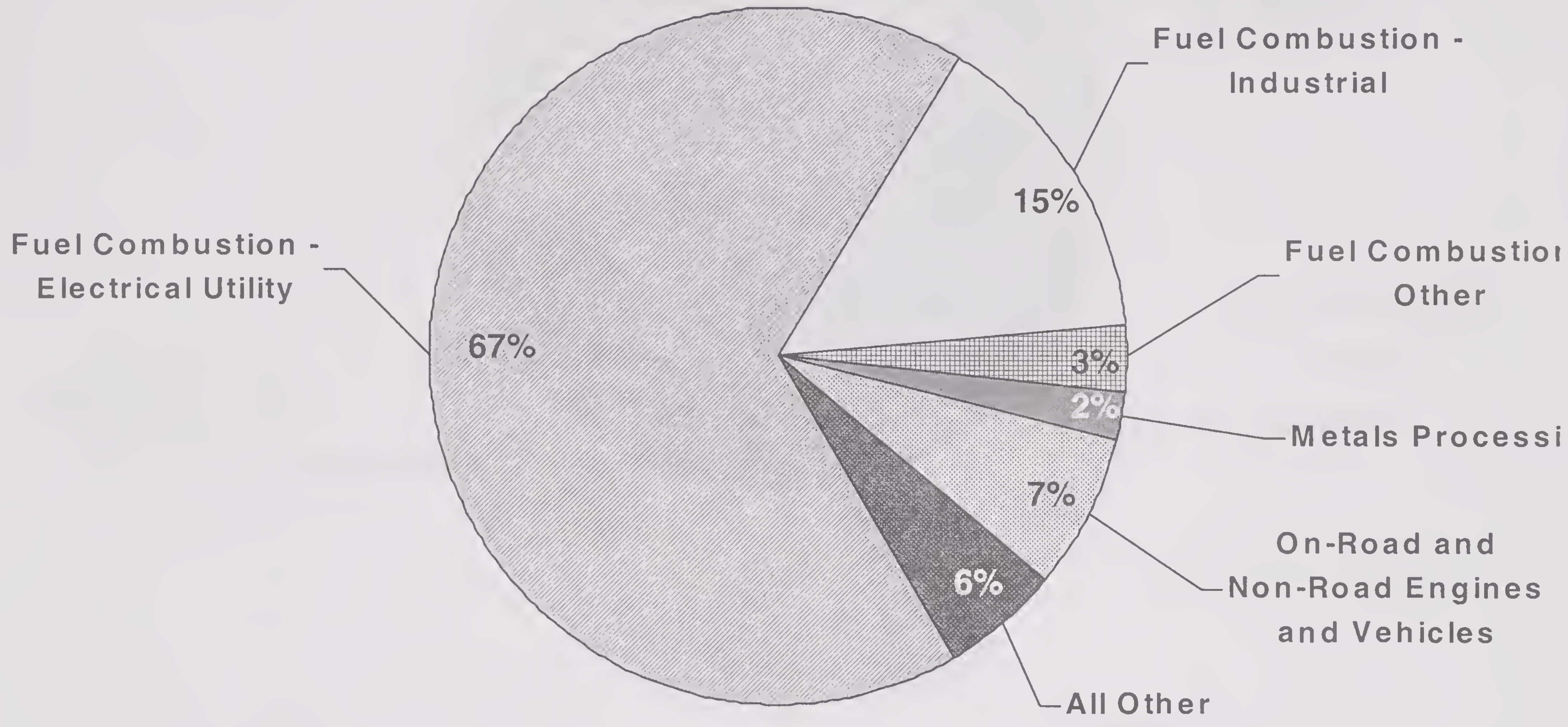
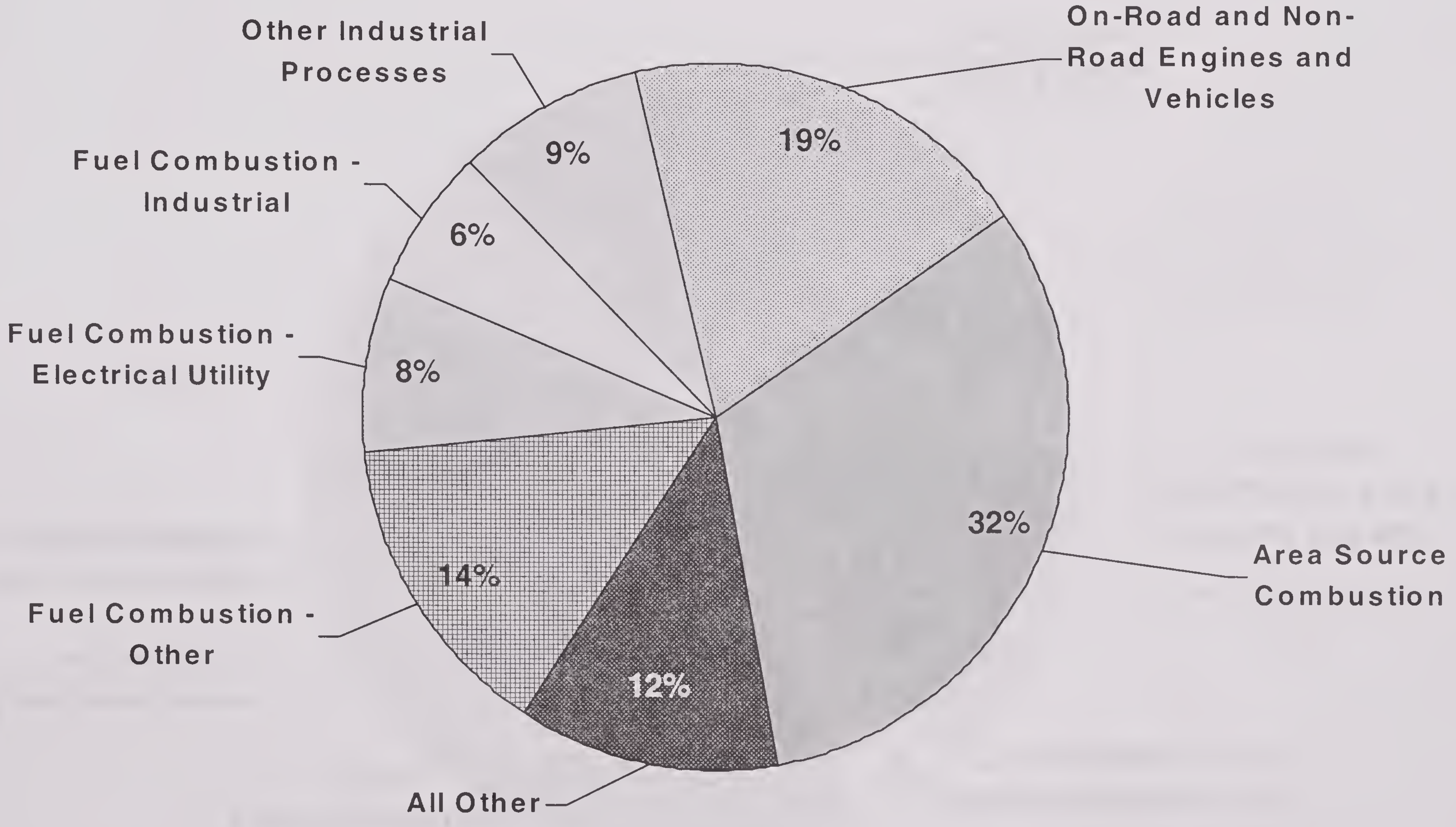
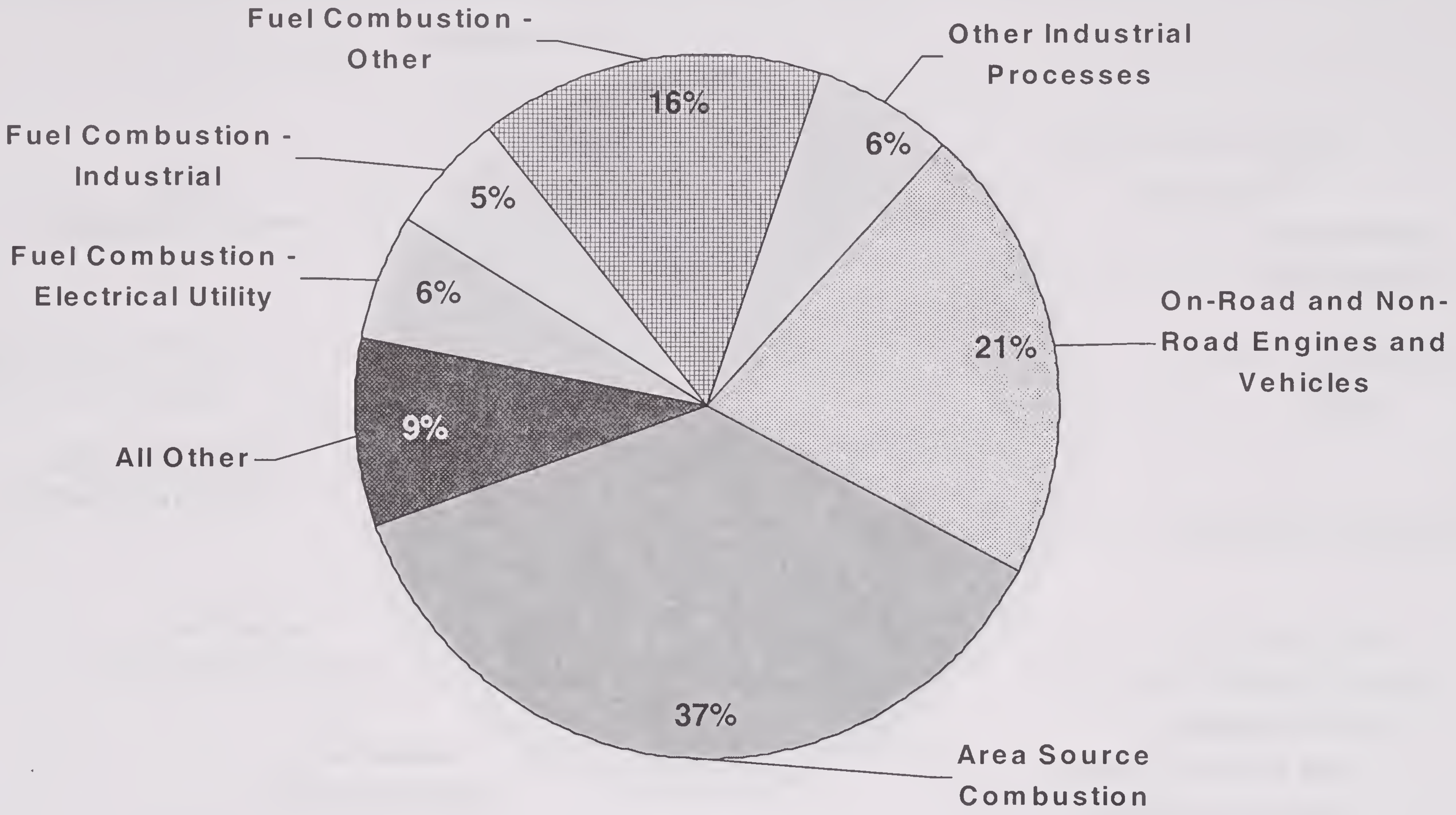


Figure 2-5. 1998 Directly Emitted National PARTICULATE MATTER (PM_{10}) Emissions by Principal Source Categories for Nonfugitive Dust Sources



For a complete understanding of $PM_{2.5}$ emissions, one should also consider the emissions of SO_2, NO_x, and NH_3. These gases react in the atmosphere to form ammonium sulfate and ammonium nitrate fine particles; also, some organic particles are formed from VOCs. These "secondary" fine particles (in contrast to the directly emitted particles from combustion and fugitive dust) can comprise as much as half the $PM_{2.5}$ measured in the United States.[7] Source apportionment studies exist to help elucidate the role of primary PM (reflected in the NET) and secondary PM. Note that emissions from fugitive dust sources are not included in the figure.

Figure 2-6. 1998 Directly Emitted National PARTICULATE MATTER ($PM_{2.5}$) Emissions by Principal Source Categories for Nonfugitive Dust Sources



For a complete understanding of $PM_{2.5}$ emissions, one should also consider the emissions of SO_2, NO_x, and NH_3. These gases react in the atmosphere to form ammonium sulfate and ammonium nitrate fine particles; also, some organic particles are formed from VOCs. These "secondary" fine particles (in contrast to the directly emitted particles from combustion and fugitive dust) can comprise as much as half the $PM_{2.5}$ measured in the United States.[7] Source apportionment studies exist to help elucidate the role of primary PM (reflected in the NET) and secondary PM. Note that emissions from fugitive dust sources are not included in the figure.

Figure 2-7. 1998 National LEAD Emissions by Principal Source Categories

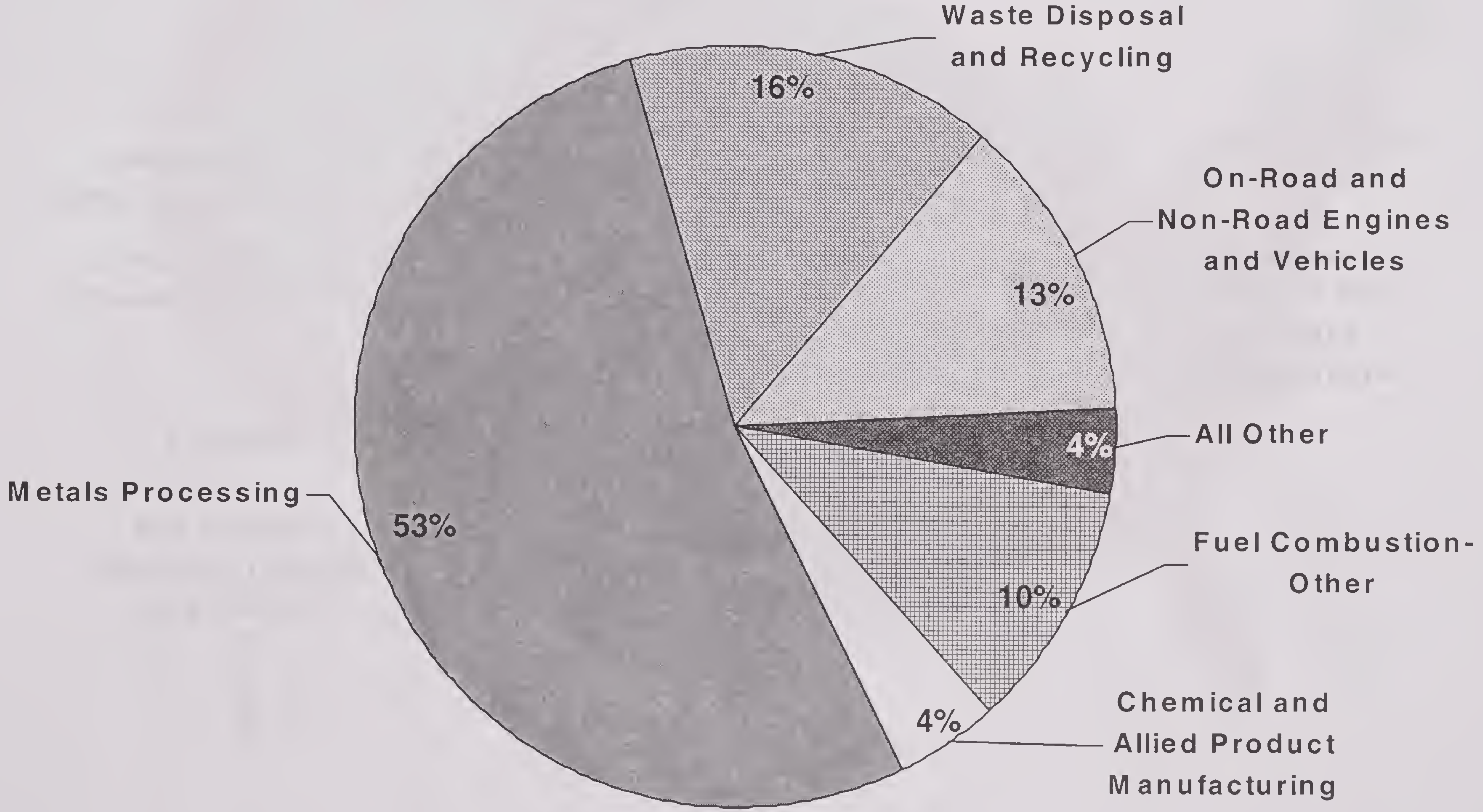
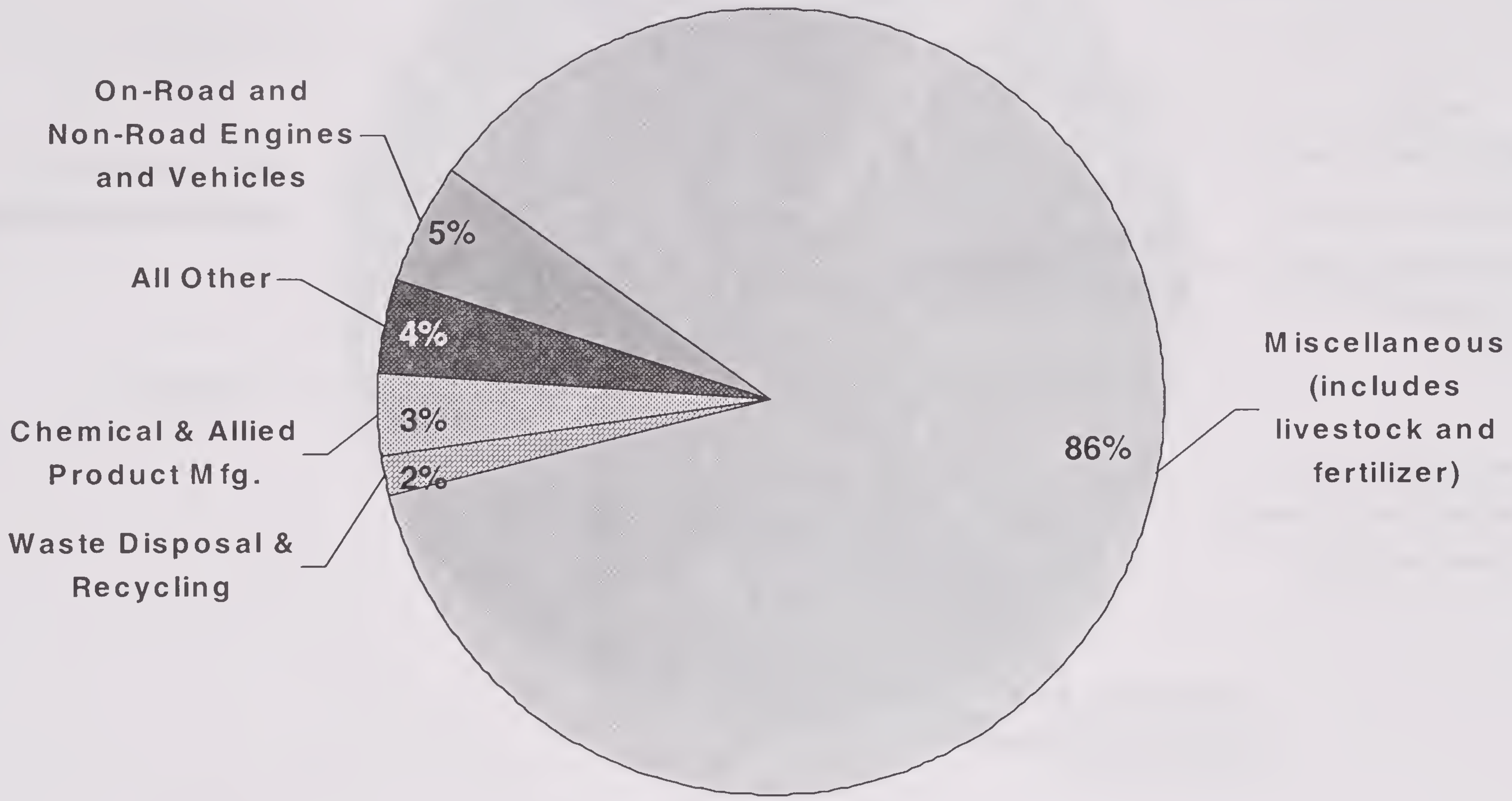


Figure 2-8. 1998 National AMMONIA Emissions by Principal Source Categories



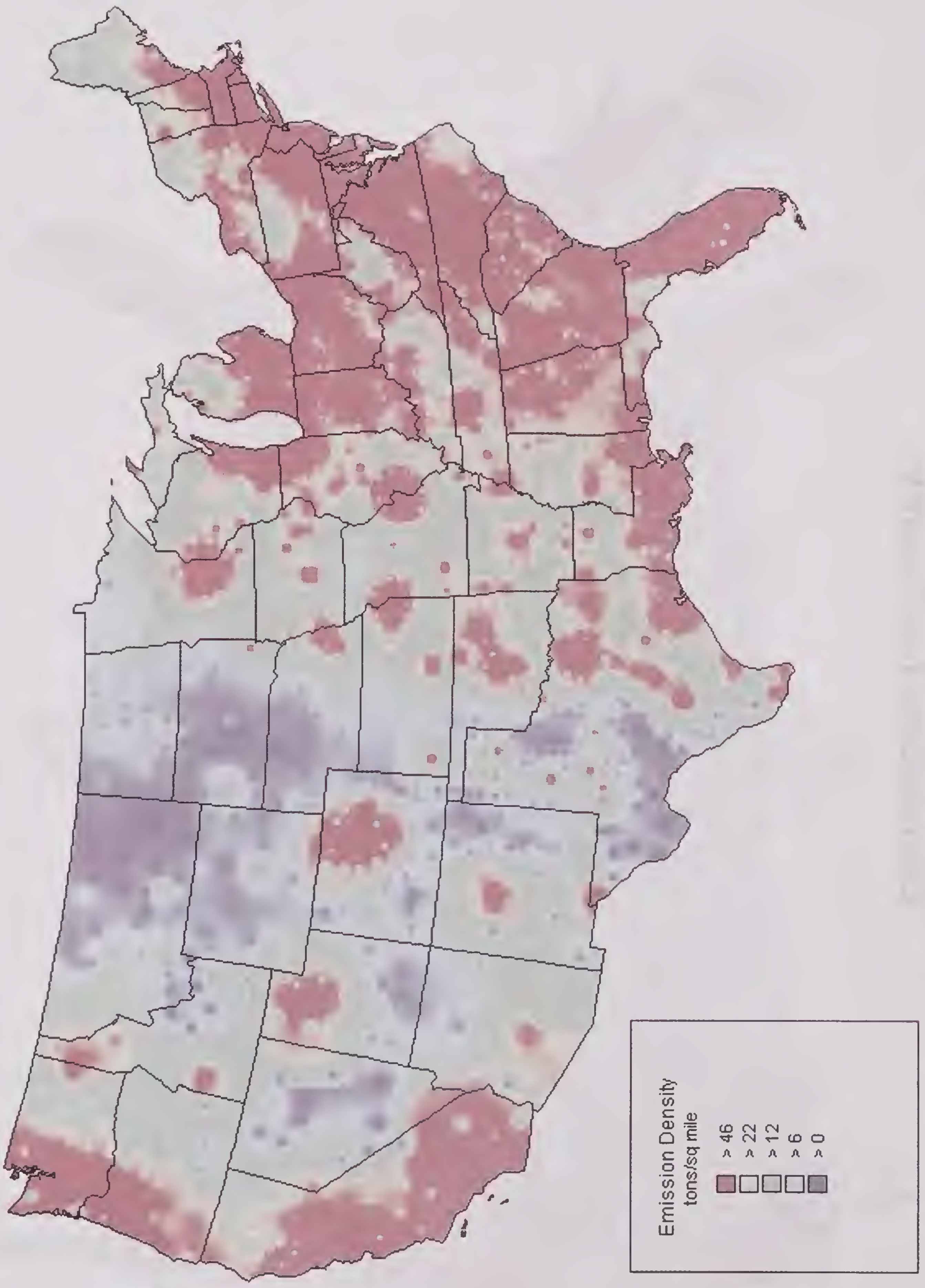

Emission Density
tons/sq mile
▨ > 46
☐ > 22
☐ > 12
☐ > 6
▨ > 0

Figure 2-9. Density Map of 1998 CARBON MONOXIDE Emissions by County

Figure 2-10. Density Map of 1998 NITROGEN OXIDE Emissions by County

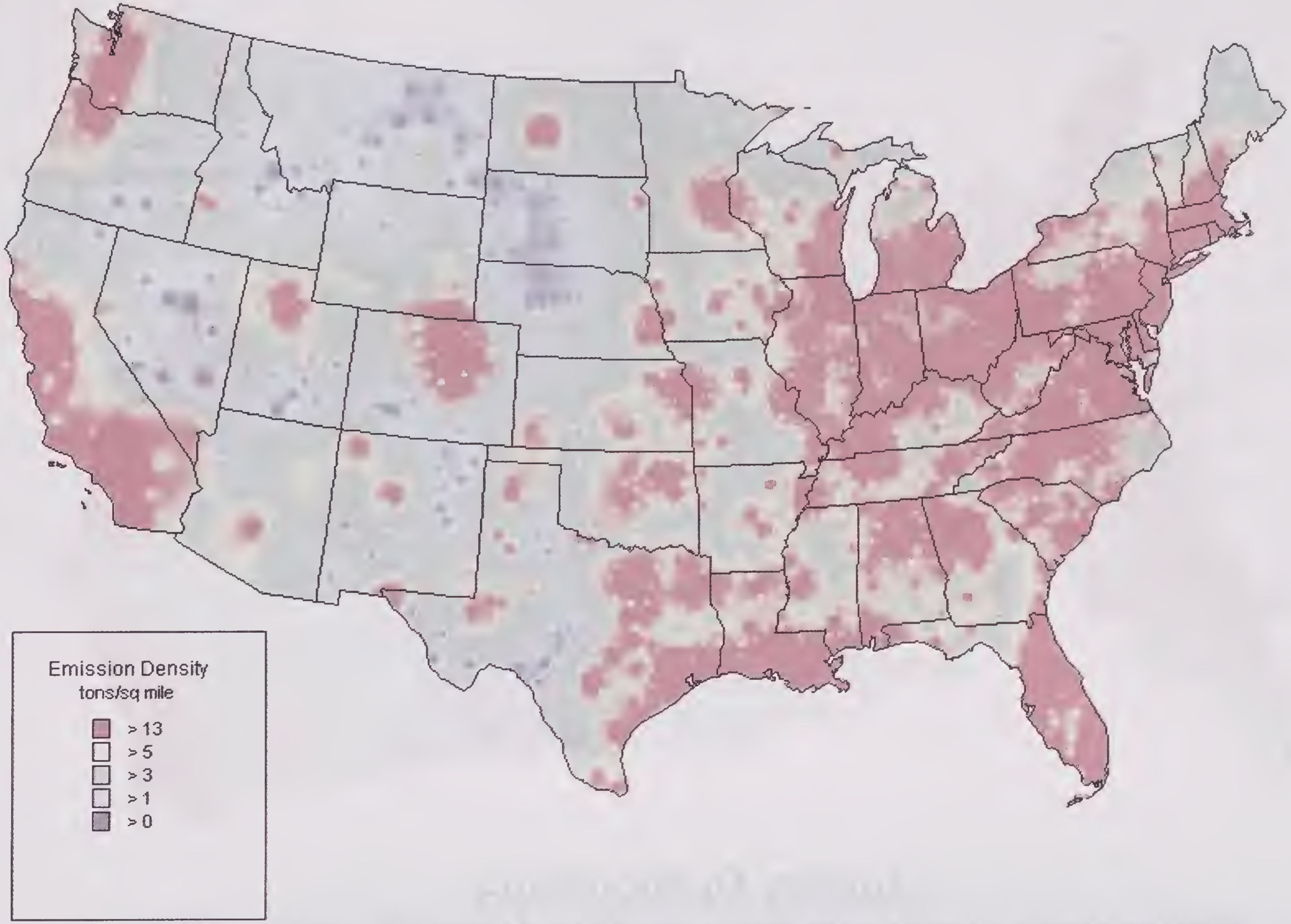

Emission Density
tons/sq mile
> 13
> 5
> 3
> 1
> 0

Figure 2-11. Density Map of 1998 VOLATILE ORGANIC COMPOUND Emissions by County

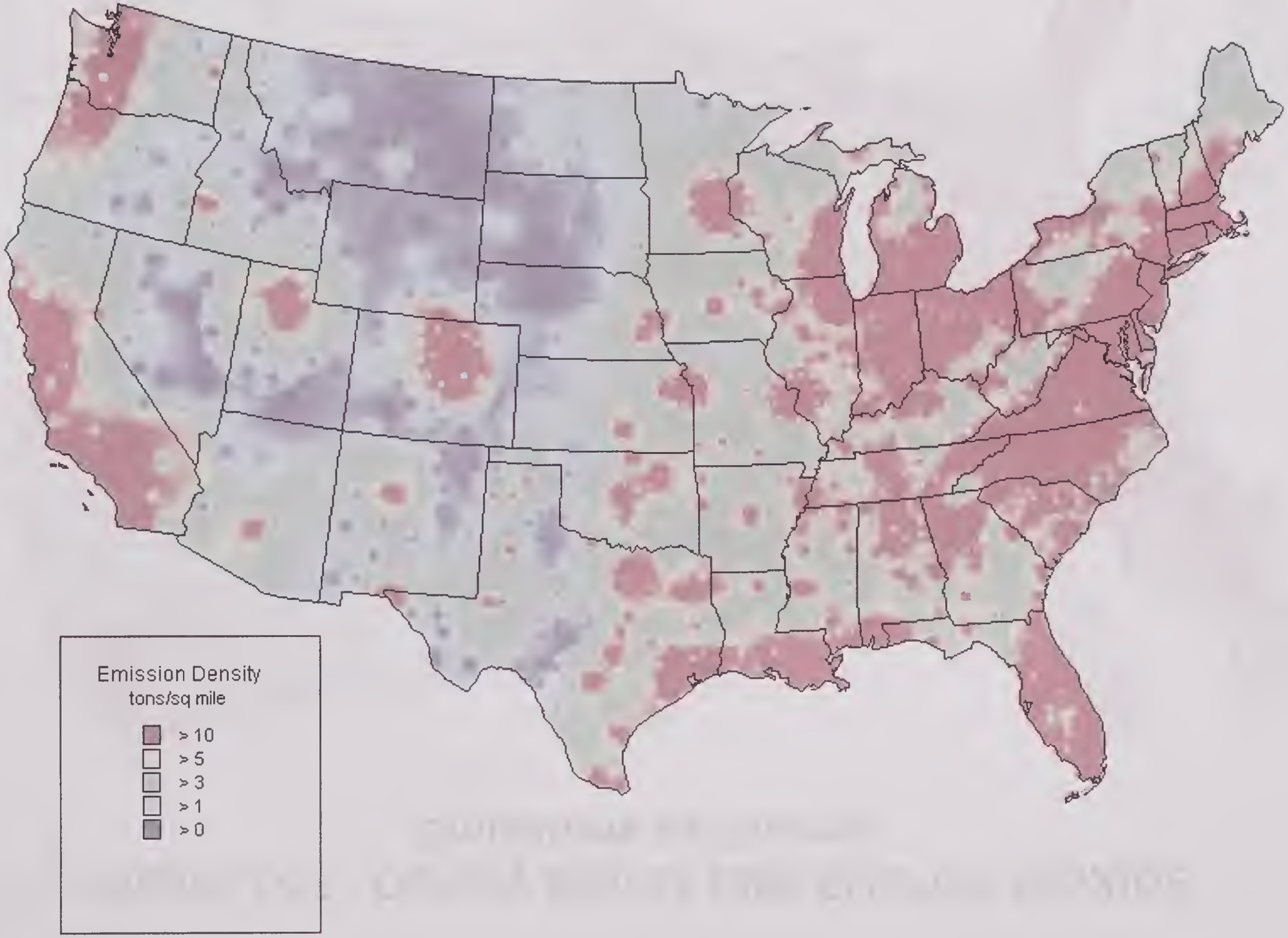

Emission Density
tons/sq mile
> 10
> 5
> 3
> 1
> 0

Figure 2-12. Density Map of 1998 SULFUR DIOXIDE Emissions by County

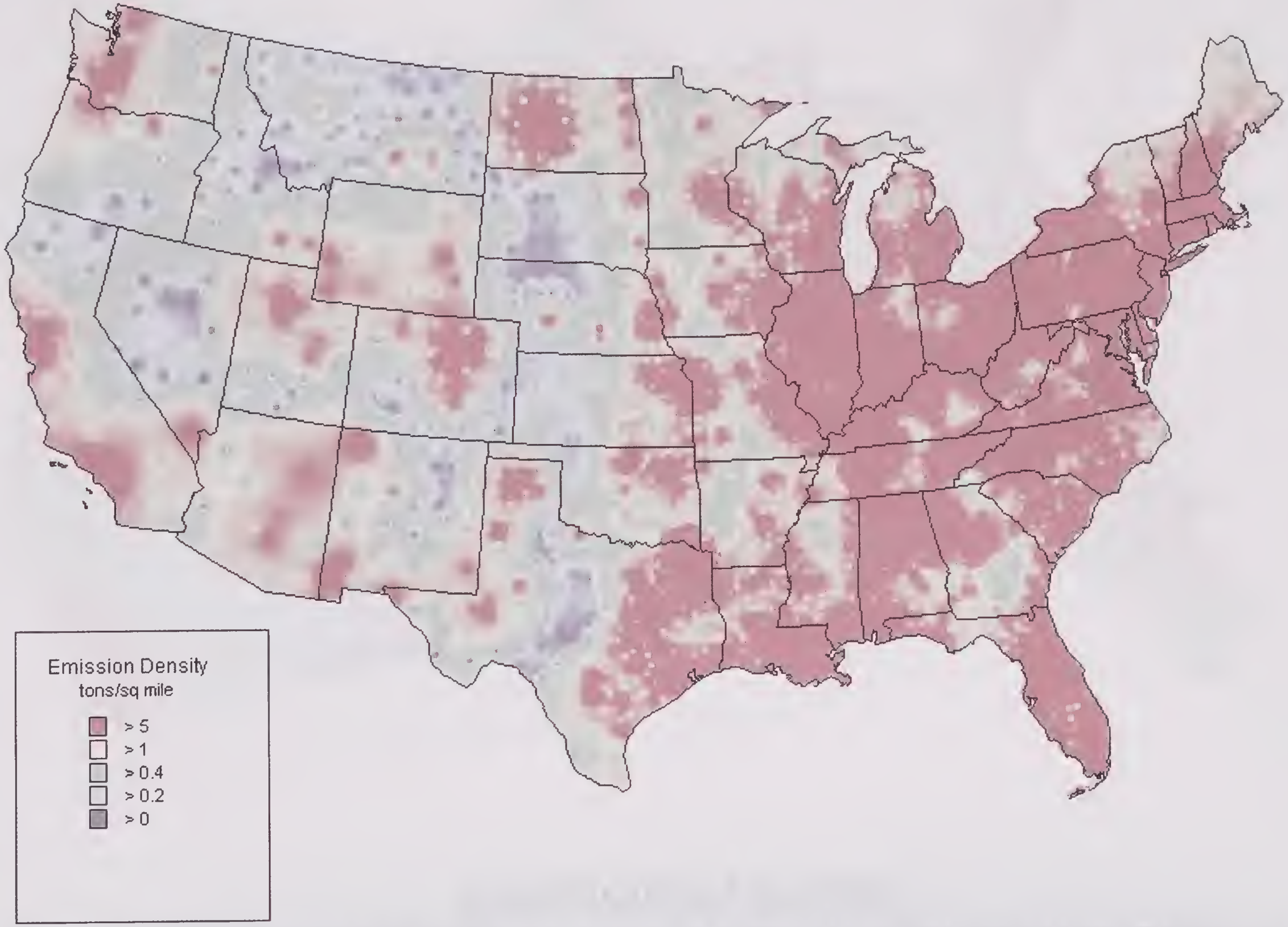

Emission Density
tons/sq mile
> 5
> 1
> 0.4
> 0.2
> 0

Figure 2-13. Density Map of 1998 PARTICULATE MATTER (PM_{10}) Emissions by County

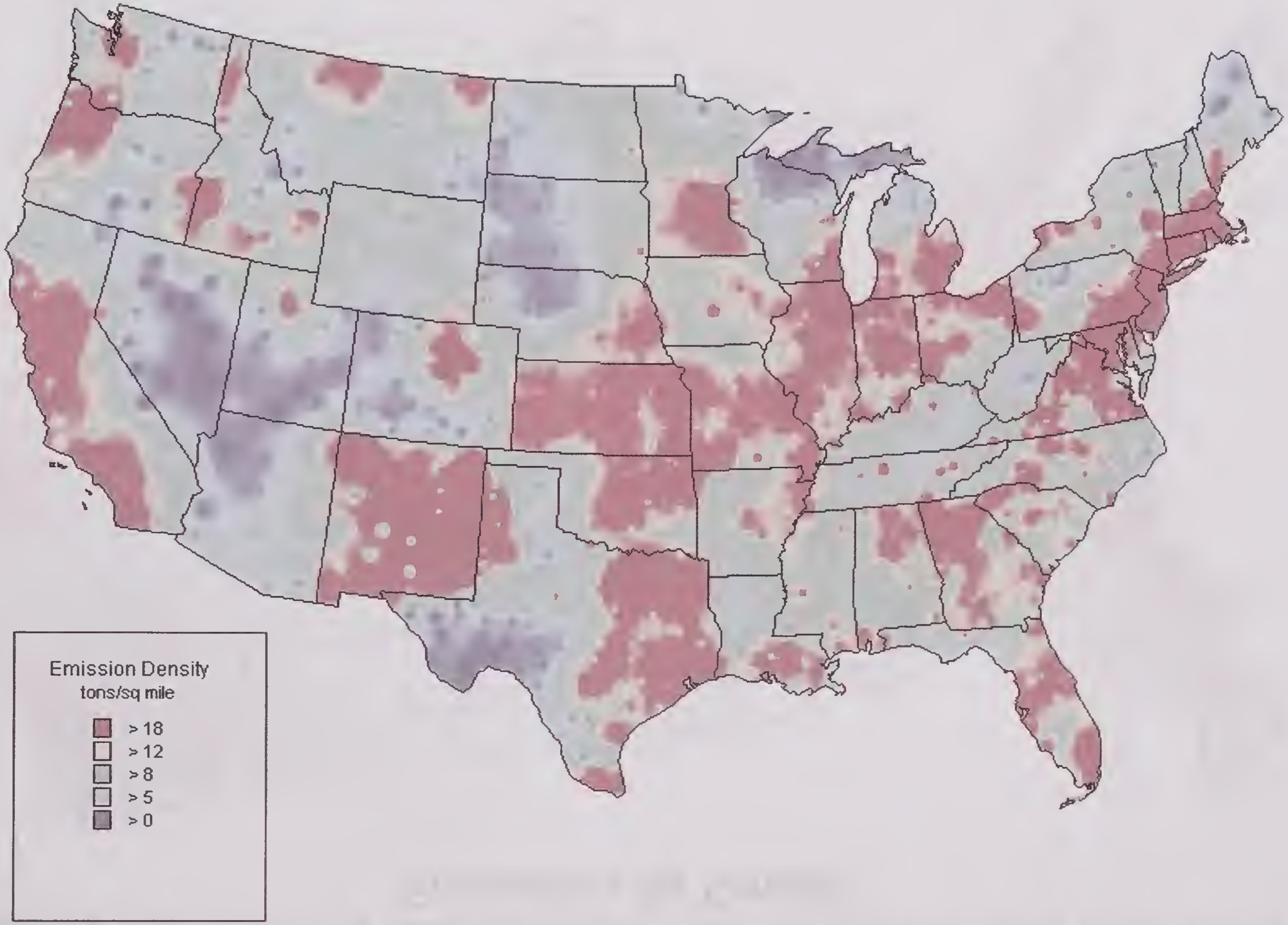

Emission Density
tons/sq mile
🟥 > 18
☐ > 12
☐ > 8
☐ > 5
🟪 > 0

Figure 2-14. Density Map of 1998 PARTICULATE MATTER ($PM_{2.5}$) Emissions by County

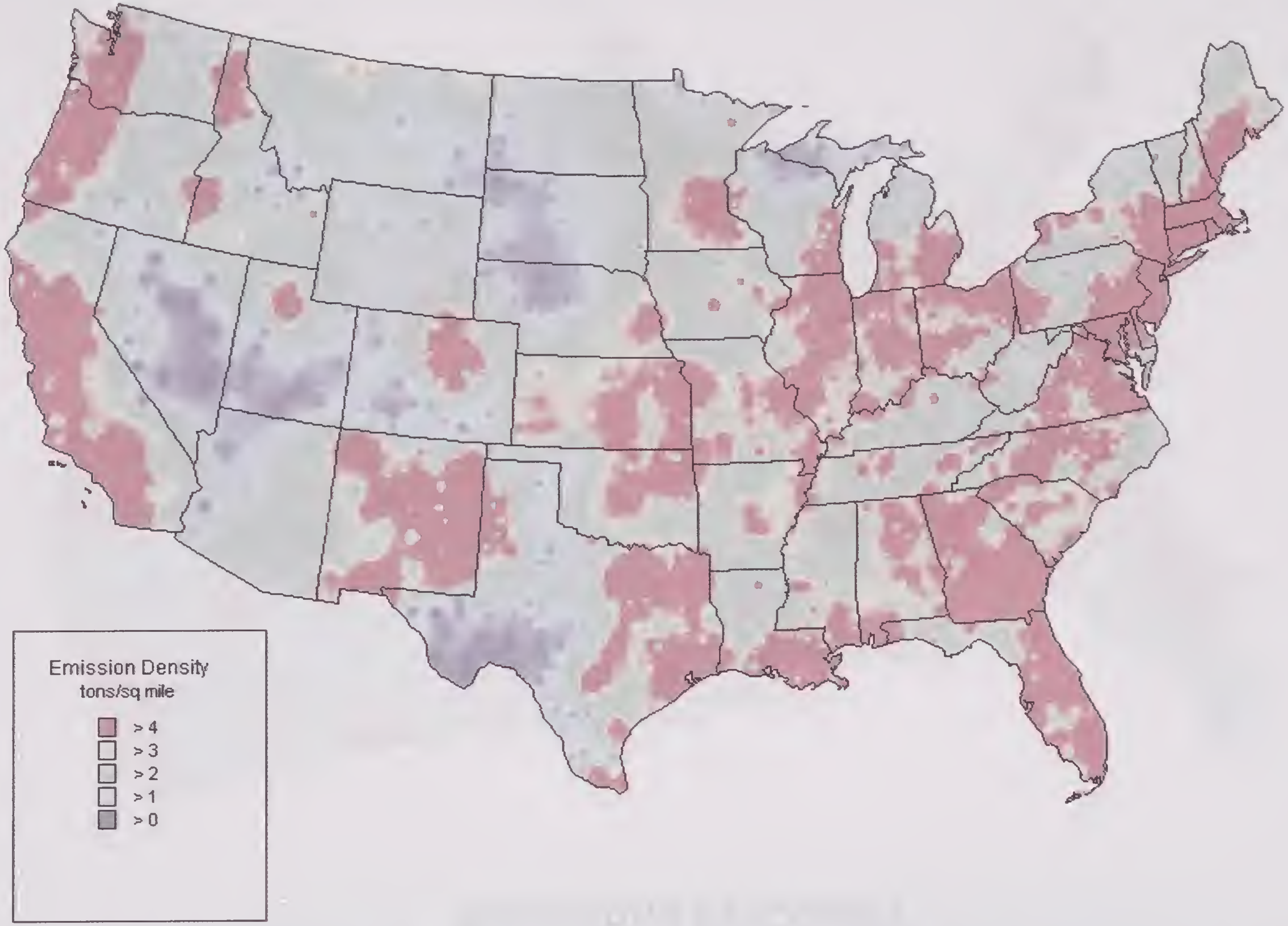
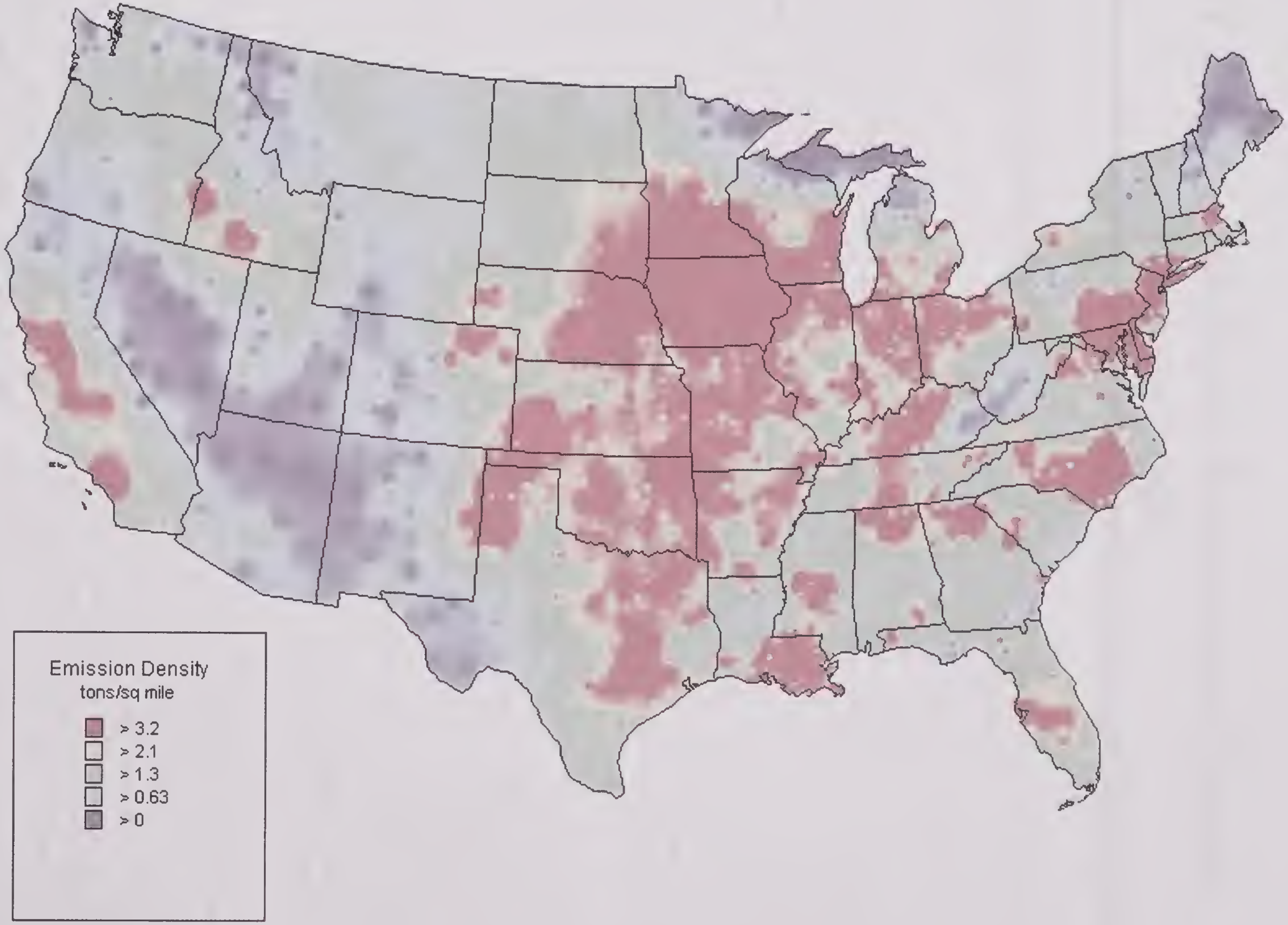

Emission Density
tons/sq mile
🟥 > 4
☐ > 3
☐ > 2
☐ > 1
▨ > 0

Figure 2-15. Density Map of 1998 AMMONIA Emissions by County


Emission Density
tons/sq mile
> 3.2
> 2.1
> 1.3
> 0.63
> 0

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Chapter 3.0 National Emissions Trends, 1900 to 1998

3.1 WHAT DATA ARE PRESENTED IN THIS CHAPTER?

This chapter presents historical trends in air pollutant emissions [carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs), sulfur dioxide (SO_2), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), and lead (Pb). Although not a criteria pollutant, emission estimates for ammonia (NH_3)] for the period 1900 through 1998 (where available). The source categories discussed in this chapter include: fuel combustion, industrial processes (chemical and allied products, metals processing, petroleum and related industries, other industrial processes, solvent utilization, storage and transport, and waste disposal and recycling), on-road vehicles, non-road engines and vehicles, and miscellaneous. This chapter also describes the effects that national economic activity and regulatory efforts have had on air pollutant emissions trends.

In this chapter, values representing changing emissions or the percentage change in emissions over various time periods are presented. It is important for the reader to realize that all values are estimates only and possess a large degree of uncertainty. Uncertainty analyses are ongoing at the United States (U.S.) Environmental Protection Agency (EPA) and will be reported in the FY2001 report.

3.2 WHEN DID AIR POLLUTION CONTROL EFFORTS BEGIN AND HOW HAVE THEY EVOLVED?

In 1881, the cities of Chicago and Cincinnati, in an effort to control smoke and soot primarily from furnaces and locomotives, passed the first air pollution statutes in the United States. By the early 1900s, county governments began to pass their own pollution control laws. In 1952, Oregon became the first state to legislatively control air pollution, and other states soon followed, enacting air pollution statutes generally aimed at controlling smoke and particulates.

The Federal Government became involved in air pollution control in 1955 with the passage of the Air Pollution Control Act. This law limited Federal involvement in air pollution control to providing funding assistance for the States' air pollution research and training efforts. The shift by the Federal Government toward greater involvement in air pollution control began with the passage of the original Clean Air Act (CAA) in 1963. This act provided permanent Federal support for air pollution research, continued and increased Federal assistance to states for developing their air pollution control agencies, and a mechanism through which the Federal Government could assist states with cross-boundary air pollution problems. In 1965, Congress amended the CAA for the first time, directing the Secretary of Health, Education, and Welfare to set the first Federal emissions standards for motor vehicles.

In 1967, Congress passed the Air Quality Act, which required that states establish air quality control regions and that Health, Education, and Welfare, through the National Air Pollution Control Administration, conduct research on the effects of air pollution, operate a monitoring network, and promulgate criteria to serve as the basis for setting emission standards. States would then use the HEW information to set air quality standards. In addition, the Air Quality Act directed HEW to identify control technologies for states to use to attain the air quality standards that each state was to have established.

Several problems undermined this early period of federal air pollution control. The HEW belatedly issued guidance documents detailing the adverse health effects associated with common air pollutants; where guidance documents had been prepared, states either failed to set air quality standards or failed to develop implementation plans in a timely manner. In addition, the initial exhaust emission standards set by HEW in 1968 resulted only in relatively small reductions in automobile pollutants.

1970 marked the beginning of several major changes to federal air pollution control efforts. First, the Federal Government created a new federal agency, the EPA, on December 2, 1970, and charged it with the responsibility of setting National Ambient Air Quality Standards (NAAQS). Second, EPA was given the authority to develop national emissions standards for cars, trucks, and buses. Finally, Congress gave EPA the power to set emissions performance standards [known as new source performance standards (NSPS)] for all new sources of the common air pollutants. Under the CAA, the only major responsibility that states retained was that of determining how to control existing sources.

In response to its mandate, the EPA promulgated primary and secondary NAAQS in 1971 for photochemical oxidants, SO_2, total suspended particulate (TSP), CO, and hydrocarbons. To comply with each of the NAAQS by a 1975 deadline, states had to develop and implement State Implementation Plans (SIPs) that would demonstrate how existing sources would be controlled. In 1977, Congress made additional modifications to the CAA, laying the groundwork for more significant changes to occur with the passage of the CAA Amendments (CAAA).

The photochemical oxidants standard formulated by EPA in 1971 set an hourly average level that was not to be exceeded more than once per year. In 1979, EPA changed the chemical designation of the NAAQS from photochemical oxidants to ozone (O_3). In 1979, EPA revised the O_3 standard from 0.08 parts per million (ppm) of O_3 to 0.12 ppm of O_3 measured over a 1-hour period, not to be exceeded more than three times in a 3-year period. In July 1997, EPA once again revised the O_3 standard, returning it to 0.08 ppm of O_3 but measured over an 8-hour period, where a formal exceedance was triggered by the fourth highest concentration over a 3-year period. The District of Columbia Circuit Court remanded this revision in May of 1999, placing the status of the new 8-hour O_3 NAAQS in question.

The regulatory discussion in this report is not comprehensive; instead, it emphasizes some of the regulatory efforts that have targeted the major source categories for each air pollutant. An example is the national Acid Rain Program authorized by Title IV of the 1990 CAAA. The initial phase of its innovative market-based SO_2 reduction program began in 1995 and, during the first year of compliance, utilities cut SO_2 emissions from their Phase I (Table A) units by approximately 40 percent. Phase I of the Acid Rain NO_x reduction program, a more conventional rate-based control program for coal-fired utility boilers, began in 1996 and contributed to the general decline in NO_x emissions in the late 1990s.

However, the lack of detail available for all of the data precludes the possibility of analyzing some of the stationary source control measures [for example, state-specific regulations such as reasonably available control technology (RACT) provisions]. As a point of reference, Figure 3-1 presents the trends in gross domestic product (GDP), population, vehicle miles traveled (VMT), and total fuel consumption (that is, total fuel consumed by industrial, residential, commercial, and transportation sectors) from 1970 to 1998.

In the fall of 1998, EPA issued a new regulation requiring 22 states and the District of Columbia to submit SIPs to diminish the regional transport of ground-level O_3 through reductions in NO_x. This regulation is commonly known as the NO_x SIP call. By reducing NO_x emissions, this rule aims to reduce the transport of ground-level ozone across state boundaries in the eastern half of the United States. The rule requires NO_x emission reduction measures to be in place by May 1, 2003. While EPA does not mandate which sources must reduce pollution, EPA expects utilities and large non-utility point sources to be the most likely sources of NO_x emissions reductions. The rule also establishes a NO_x Budget Trading Program which should enable states to achieve over 90 percent of the required emissions reductions in a highly cost-effective manner. EPA projects that full implementation of the NO_x SIP call would reduce NO_x emissions in the eastern United States by 25 percent, or approximately 1.142 million tons, beginning in the year 2003. Timing is uncertain due to litigation.

3.3 WHAT ARE THE GENERAL HISTORICAL EMISSIONS TRENDS?

Tables 3-1 through 3-8 present emissions trends for the period 1940 through 1998 for CO, NO_x, VOC, SO_2, PM_{10}, $PM_{2.5}$, Pb, and NH_3. Appendix Tables A-1 through A-7 present detailed emissions for the years 1970 through 1998, “where available.” CO, VOC, SO_2, and Pb emissions peaked in or around 1970, with a general downward trend during the 1970 to 1998 time frame. PM_{10} emission levels peaked around 1950, steadily declined until the mid-1980s, and since then have remained relatively stable. NO_x emissions steadily increased through the mid-1970s to 24.4 million tons in 1980, declined slightly during the early 1980s, and then climbed again, exceeding 25 million tons in 1994. Total NO_x emissions have since declined slightly. From 1990 to 1998, NH_3 emissions rose by 14 percent, while $PM_{2.5}$ emissions remained relatively stable. Figures 3-2 through 3-9 depict emission estimates for each source category from 1940 to 1998 (where available).

3.3.1 How Have CO Emissions Changed?

Table 3.1 shows historical trends in CO emissions by principal source categories. Total CO emissions peaked in 1970 and decreased rather steadily thereafter. A significant decrease in CO emissions occurred between 1973 and 1975 as a result of disruptions in world oil markets and a subsequent recession in the United States. (NO_x and VOC emissions trends also showed similar short-term decreases from 1973 to 1975 for the same reasons.) The fluctuations of CO emissions in the late 1980s is due to the variation in wildfire activity from year-to-year.

3.3.2 How Have NO_x and VOC Emissions Changed?

This report often considers NO_x and VOC together because they comprise the principal components in the chemical and physical atmospheric reactions that form O_3 and other photochemical oxidants. Although an ambient air quality standard does not exist for VOC, VOC emissions are an important category from the standpoint of modeling O_3 formation.

With regard to NO_x, total national emissions increased 233 percent between 1940 and 1998. Changes in emissions over this time period are shown in Table 3-2. From 1970 to 1997, NO_x emissions increased by approximately 19 percent, followed by a slight decline in 1998.

Table 3-3 presents the trend in VOC emissions from 1940 through 1998. Total national VOC emissions rose significantly from 1940 to 1970, but then declined almost as significantly from 1970 to 1998. In fact, 1998 levels exceed 1940 VOC emission levels by less than one million tons.

When calculating VOC emissions, EPA includes those emissions of VOC species that primarily contribute to the formation of O_3 in total VOC emissions but excludes emissions of methane (CH_4), a nonreactive compound. EPA makes no adjustments to include chlorofluorocarbons (CFCs) or to exclude ethane and other VOCs with negligible photochemical reactivity, and it estimates on-road vehicle emissions as nonmethane hydrocarbons. Chapter 6 discusses emissions of organic compounds from biogenic sources such as trees and other vegetation. According to recent research, natural sources emit almost the same level of VOC emissions as anthropogenic sources, but the extent to which biogenic VOC emissions contribute to oxidant formation has not been determined.

3.3.3 How Have SO_2 Emissions Changed?

Table 3-4 presents the trend in SO_2 emissions between 1940 and 1998. National SO_2 emissions rose 56 percent from 1940 to 1970 and have since declined, primarily because of regulatory actions, especially those that targeted utility sources.

3.3.4 How Have PM_{10} Emissions Changed?

Table 3-5 presents the 1940 to 1998 trend in PM_{10} emissions. EPA divides PM_{10} sources into two categories: fugitive dust sources and nonfugitive dust sources. PM_{10} fugitive dust sources include natural sources (geogenic - wind erosion) and some miscellaneous sources. These miscellaneous sources include agriculture and forestry fugitive dust sources. The PM_{10} nonfugitive dust sources include all other PM_{10} sources. For 1998, EPA estimates that total national fugitive dust PM_{10} emissions are approximately 8 times greater than total emissions from nonfugitive dust sources. Since 1990, emissions from fugitive dust sources have increased slightly, primarily as the result of increases in unpaved road and construction emissions.

3.3.5 How Have $PM_{2.5}$ Emissions Changed?

This most recent Trends report includes data on $PM_{2.5}$ emission trends since 1990. EPA originally developed emissions estimates for $PM_{2.5}$ under the National Particulate Inventory (NPI). This study consisted of a 1990 air emissions inventory for the United States (excluding Alaska and Hawaii), Canada, and Mexico. For the *1998 Trends* report, EPA uses State particulate data where available to develop $PM_{2.5}$ estimates. As can be seen in Table 3-6, overall $PM_{2.5}$ emissions remain relatively constant from 1990 to 1998, while emissions from residential wood combustion decline significantly and emissions from natural sources fluctuate.

3.3.6 How Have Pb Emissions Changed?

Table 3-7 provides data on Pb emissions from 1970 through 1998. The promulgation of a national ambient air quality standard for Pb in October 1978 has been the primary force behind the dramatic decrease in Pb emissions from 220,869 tons in 1970 to 3,973 tons in 1998.

3.3.7 How Have NH_3 Emissions Changed?

This Trends report also includes data on NH_3 emission trends since 1990. Table 3-8 presents the emissions data for NH_3 since 1990. Fuel combustion-industrial, on-road vehicles, and miscellaneous sources saw the greatest growth in emissions during the 1990s, while chemical and allied product manufacturing and petroleum and related industries saw the greatest declines in emissions during that same period.

3.4 HOW HAVE EMISSIONS IN THE MAJOR SOURCE CATEGORIES CHANGED?

This section discusses the trends in emissions from a source category perspective rather than a pollutant perspective. While each pollutant is discussed relative to the source category being considered, the main emphasis is on the changes that have occurred in that source category. In addition, this section occasionally discusses long term trends in emissions. As a point of reference, Table 3-13 presents total national (but not source category specific) emission estimates for each pollutant for each year available from 1900 to 1998.

3.4.1 How Have Emissions in the Stationary Source Fuel Combustion Categories Changed?

The three stationary source fuel combustion categories are fuel combustion - electric utility, fuel combustion - industrial, and fuel combustion - other. Fuel combustion - other includes commercial/institutional coal, commercial/institutional oil, commercial/institutional gas, miscellaneous fuel combustion (except residential), residential wood and residential other. Figures 3-2 through 3-9, present trends in CO, NO_x, VOC, PM, $PM_{2.5}$, Pb, and NH_3 emissions from fuel combustion sources from as early as 1940 in most cases, to 1998.

Emissions of SO_2 from fuel combustion sources peaked in 1973, declined sharply in the mid 1990s, but are rising again. NO_x emissions from fuel combustion sources peaked a few years later, in 1977, and remained approximately constant at their peak level through the mid 1990s. Meanwhile, VOC and PM_{10} emissions declined steadily from 1940 until the early 1970s. Emissions then rose, but declined again in the late 1980s. Pb emissions peaked in 1972 and have since declined significantly. Although overall CO emissions declined steadily from 1940 until 1970, they reversed trend after 1970, peaking at 8 million tons in 1985. $PM_{2.5}$ emissions have declined overall between 1990 and 1998. While NH_3 emissions from fuel combustion sources rose slightly since 1990, fuel combustion contributed less than 2 percent to national total NH_3 emissions throughout the 1990s.

Historically, residential wood contributes the largest quantity of fuel combustion CO and VOC emissions. Therefore, despite a gradual increase in CO and VOC emissions from electric utilities and industrial sources since 1940, the more substantial decline in emissions from residential wood consumption since 1985 accounts for the overall decline from the fuel combustion category since 1985. CO and VOC emissions from the fuel combustion category accounted for 16 and 12 percent of total national CO and VOC emissions in 1940 but only 6 and 5 percent in 1998.

In 1900, emissions from all fuel combustion sources represented 68 percent of total national VOC emissions, with residential wood combustion accounting for 90 percent of those emissions. From 1940 to 1970, residential wood consumption declined steadily as a result of the abundant supply, low relative prices, and convenience of fossil fuels relative to wood for home heating, cooking, and heating water. This decline halted in the early 1970s because disruptions in crude oil deliveries and related product markets caused prices for fossil fuel products to rise. These higher prices led to a resurgence in the use of wood for home heating and thus to a corresponding increase in emissions from residential wood combustion. By 1980, though, prices of fossil fuel products once again began to decline. As a result, residential wood consumption once again declined, as did the corresponding CO and VOC emissions.

With regard to NO_x, electric utilities contribute the largest percentage of NO_x emissions from the stationary source fuel combustion categories. In 1900, electric utilities accounted for 4 percent of total national 1998 NO_x emissions, but by 1998 they accounted for 25 percent of total national NO_x emissions. Coal accounted for 88 percent of the electric utility NO_x emissions in 1998.

Fuel combustion-industrial contributes approximately 12 percent of total national 1998 NO_x emissions. While emissions from this source have generally declined since 1970, they rose slightly from 1992 to 1996 (see Appendix Table A-2). Meanwhile, NO_x emissions from fuel combustion - other generally increased since 1940, although a small decline has occurred since 1992. Fuel combustion - other contributed less than 5 percent of total national NO_x emissions in 1998.

As with NO_x emissions, electric utilities contributed 4 percent of total national SO_2 emissions in 1900. These emissions increased by a factor of 5 over the period 1900 to 1925, but the onset of the Great Depression put a halt to the growth in these emissions during the 1930s. As the United States recovered from the Depression, emissions from electric utilities once again rose. By 1940, SO_2 emissions levels approximated pre-1930 levels. From 1940 to 1970, SO_2 emissions from electric utilities doubled every decade as a result of increased coal consumption. By 1970, emissions from coal combustion accounted for more than 90 percent of total SO_2 emissions from electric utilities. With the help of regulatory controls, SO_2 emissions from electric utilities using all types of energy sources decreased approximately 38 percent from 1970 to 1996 (see Table A-4). Despite this decrease, electric utilities still accounted for 67 percent of the total national SO_2 emissions in 1998.

In 1940, PM_{10} emissions from fuel combustion represented approximately 31 percent of nonfugitive dust PM_{10} emissions. Electric utility PM_{10} emissions derive primarily from the combustion of coal. Emissions from this electric utilities increased by approximately 85 percent between 1940 and 1970, which corresponds to an increase in electric production using coal as an energy source during the same time period. Fuel combustion PM_{10} emissions have since declined from 1970 levels. In terms of $PM_{2.5}$, overall fuel combustion emissions remained fairly steady from 1990 through 1998. Fuel combustion sources contributed 9 percent of total national 1998 $PM_{2.5}$ emissions

Fuel combustion sources accounted for 5 percent of total national Pb emissions in 1970. Despite a 95 percent decline since 1970, fuel combustion sources still accounted for 13 percent of total national Pb emissions in 1998. Fuel combustion's contribution to total NH_3 emissions remained less than 2 percent throughout the 1990 to 1998 time frame.

The overall decline in emissions from fuel combustion sources since the 1970s can be attributed to various regulatory actions. As mentioned previously, SO_2 emissions from electric utilities using all types of energy sources decreased approximately 24 percent from 1970 to 1998. The SO_2

NAAQS, promulgated in 1971, served as a primary factor in reducing SO_2 emissions. Another factor was EPA's development of a NSPS in 1971. This NSPS required that all new coal-fired power plants emit no more than 1.2 pounds of SO_2 per each million British thermal units (Btus) of electricity produced. Most new plants chose to meet this NSPS by shifting to lower-sulfur coals. An amendment to the CAA in 1977 effectively required any new coal-fired power plant not only to meet the original NSPS, but also to use some form of scrubbing equipment, even when using low-sulfur coal. Beginning in December 1976, a NSPS for new, modified, or reconstructed fossil-fuel-fired steam generators became effective, further promoting reductions in fuel combustion emissions. To help reduce PM emissions, EPA promulgated a TSP NAAQS in 1971. In 1987, EPA revised the TSP standard to include only PM_{10}.

As a result of EPA's regulations, SO_2 and PM_{10} emissions from coal-fired electric power facilities fell by 8 and 85 percent, respectively, between 1970 and 1993, despite the fact that consumption of coal to produce electricity increased 150 percent during that same period.[2]

Title IV (Acid Deposition Control) of the CAAA is an important factor in the decline in SO_2 emissions from fuel combustion sources and has contributed to the general decline of NO_x emissions. Title IV specifies that annual SO_2 emissions must decrease by 10 million tons from 1980 emissions levels and suggests, as a guideline, that annual NO_x emissions be reduced by 2 million tons from 1980 levels. Title IV defines two stages by which SO_2 reductions must occur. Phase I, which affects 263 mostly coal-fired units, began January 1, 1995. Phase II, which applies to the remaining affected Title IV units, began January 1, 2000. To achieve these reductions in a cost effective manner, utilities may choose from among a variety of possibilities, including participating in a market-based allowance trading system.[3]

Many utilities switched to low sulfur coal and some installed flue gas desulfurization equipment (also known as scrubbers) for their Phase I units, thereby achieving reductions in SO_2 emissions greater than those required under Title IV. These changes enabled utilities to reduce SO_2 emissions from their Phase I units from 7.4 million tons in 1994 to 4.5 million tons in 1995, the first year of compliance.

3.4.2 How Have Emissions in the Industrial Process Categories Changed?

Industrial processes include the following Tier 1 categories: chemical and allied products; metals processing; petroleum and related industries; other industrial processes; solvent utilization; storage and transport; and waste disposal and recycling.

CO, NO_x, and VOC emissions from industrial processes peaked in 1950, 1960, and 1980, respectively. Industrial processes accounted for 12 percent of total national CO emissions in 1940 and 13 percent in 1970, but only 5 percent of total national CO emissions in 1998. With regard to NO_x emissions, industrial processes historically account for only a small percentage of the national total. Industrial processes accounted for an increasing share of national VOC emissions between 1900 and 1970. Although VOC emissions from industrial process sources declined by 41 percent from 1970 to 1998, they still account for 47 percent of total national VOC emissions. Emission control devices and process changes contributed to the decline in actual VOC emissions since 1970.

CO emissions from petroleum and related industries increased by a factor of 10 between 1940 and 1970 due to increases in refinery throughput and in demand for refined petroleum products. Since 1970, CO emissions from the petroleum refining industry have decreased by 83 percent due to the installation of emission control devices such as fluid catalytic cracking units and the retirement of obsolete high polluting processes such as the manufacture of carbon black by channel process. By 1998, petroleum refining accounted for less than 1 percent of total national CO emissions.

As mentioned previously, industrial processes account for only a small percentage of the national total NO_x emissions. Within the industrial process category, though, waste disposal and recycling contributed the highest percentage of NO_x emissions from 1940 to 1970. NO_x emissions from the waste disposal and recycling category increased by 300 percent from 1940 to 1970, but then decreased by 78 percent from 1970 to 1998 to less than 1940 levels. After 1970, the other industrial processes category surpassed waste disposal and recycling as the biggest contributor of industrial process NO_x emissions. The 34 percent increase in NO_x emissions from industrial processes from 1980 to 1998 occurred partly because of a change in the methodology used to estimate emissions between 1984 and 1985.

Emissions of VOCs from petroleum and related industries and petroleum product storage and marketing operations increased during the mid-1970s as a result of increased demand for petroleum products, especially motor gasoline. After 1980, the emissions from these sources decreased as the result of product reformulation and the implementation of pollutant control measures.

Industrial process SO_2 emissions peaked in 1970, when they contributed approximately 23 percent of the total national SO_2 emissions. From 1970 to 1998, emissions decreased by 79 percent, and by 1998 industrial processes only contributed 8 percent of the national total SO_2 emissions.

A major reason for the decline in industrial process SO_2 emissions since 1970 comes from the decline in metals processing emissions. Although SO_2 emissions from metals processing increased by 44 percent over the period 1940 to 1970, they decreased by almost 91percent from 1970 through 1998 due to the increased use of emission control devices. By 1998, metals processing accounted for approximately 2 percent of total national SO_2 emissions in 1998, down from 15 percent in 1970. In addition, SO_2 emissions from nonferrous smelters have fallen significantly. By-product recovery of sulfuric acid at these smelters has increased since 1970, resulting in the recovered sulfuric acid not being emitted as SO_2.

Historically, copper processing contributed the largest percentage of metals processing SO_2 emissions. To control copper processing SO_2 emissions, EPA issued a NSPS to regulate SO_2 emissions from copper smelters built, modified, or reconstructed after October 16, 1974. As a result, SO_2 emissions from copper production facilities declined almost 97 percent between 1970 and 1998, even though copper production only declined by 15 percent during the time period (1970 to 1993).[4]

Emissions of SO_2 from chemical and allied manufacturing, petroleum and related industries, and other industrial processes accounted for 4 percent of total SO_2 emissions in 1940 and 7 percent in 1970. Since 1970, SO_2 emissions from these sources have declined by 56 percent. The NSPS issued for sulfuric acid manufacturing plants built, modified, or reconstructed after 1972 is one major factor contributing to this decline.

PM_{10} emissions from industrial processes increased from 1940 to 1960, primarily as a result of increased industrial production. From 1960 to 1970, industrial output continued to grow, but PM_{10} emissions began to decline due to the installation of pollution control equipment mandated by state and local air pollution control programs. This decline was very slight, though, because the rise in emissions due to production increases more than offset the decline in emissions caused by the control devices.

In 1970, industrial processes contributed 66 percent of total national nonfugitive dust source PM_{10} emissions. By 1998, this contribution had decreased to 26 percent, reflecting the significant progress achieved in reducing emissions from industrial processes.

$PM_{2.5}$ emissions from industrial processes have remained fairly steady throughout the 1990s, although emissions from all industrial process categories declined slightly between 1995 and 1998.

In 1970, the industrial process group's Pb emissions were 13 percent of almost 221 thousand tons, nationally. Seventy-eight percent of this national total came from the on-road vehicles category which, by 1998 had been reduced to a mere 19 tons per year. Thus, while industrial process emissions of Pb have been reduced by 90 percent by 1998, they now represent 74 percent of the more dramatically reduced national total of less than 4 thousand tons per year.

Similar to $PM_{2.5}$ emissions, emissions of NH_3 from industrial process remained fairly steady throughout the 1990s. Emissions from all industrial process categories except other industrial processes declined slightly between 1995 and 1998.

3.4.3 How Have Emissions in the On-road Vehicle Categories Changed?

Historically, on-road vehicles have contributed significant amounts to national CO, NO_x, VOC, PM (if only nonfugitive dust emissions are considered), and Pb emissions levels but only small amounts to national SO_2 emission levels. The increasing popularity of motorized vehicles during the first half of the 20th century led to a corresponding increase in emissions from these vehicles.

Motorized vehicles became so popular that by 1970, on-road vehicles accounted for 35 percent of total NO_x emissions, 68 percent of total CO emissions, 42 percent of total VOC emissions, and 78 percent of total Pb emissions.

In an effort to control rising emissions levels, in the early 1970s EPA developed CO, NO_x, and VOC emission limits for on-road vehicles. Table 3-9 lists the CO emission standards, expressed in grams per mile (gpm), for light-duty vehicles (LDV) and light-duty trucks (LDT). Table 3-10 and Table 3-11 list the NO_x and VOC emissions limits for LDVs and LDTs, respectively. In addition to these limits, LDTs greater than 6,000 pounds and heavy-duty trucks must also meet NO_x emissions standards. The Federal CO standards through 1975 applied only to gasoline-powered LDTs, whereas federal standards for 1976 and later applied to both gasoline and diesel-powered LDTs. In addition, EPA requires that 1984 and later model years meet a CO standard of 0.50 percent at idle (effective with the 1988 model year at higher altitudes). Similar to the NO_x standards, other CO standards apply to LDTs more than 6,000 lbs, heavy-duty engines and vehicles, and non-road engines and vehicles.

With regard to additional CO emissions controls, the CAAA requires cars to meet a standard of 10 gpm at 20 degrees Fahrenheit, starting with the 1996 model year. This standard helps ensure that vehicular emission control devices work efficiently at low temperatures.

In general, the emission limits set by EPA resulted in significant decreases since 1970 in CO and VOC emitted by on-road vehicles. Since 1970, CO and VOC emissions from on-road vehicles have declined by almost 43 and 59 percent, respectively. NO_x emissions from on-road vehicles peaked in the late 1970s but have declined slightly since then. Although NO_x emissions levels from on-road vehicles are slightly higher than in 1970, VMT has more than doubled since 1970. The federal NO_x emissions standards have succeeded in keeping emissions growth in check.

To achieve more significant NO_x emissions reductions, EPA issued new federal tailpipe emissions standards in December 1999 for passenger cars, light trucks, and larger passenger vehicles. These standards, known as Tier II standards, should help reduce air pollution. These standards will take effect beginning in 2004 and will apply to both cars and light-duty trucks, including sport utility vehicles (SUVs).

Under the Tier II standards, affected vehicles must meet a 0.07 gpm standard for NO_x, which is a 77 percent reduction for cars and up to a 95 percent reduction for LDTs and SUVs. Vehicles weighing less than 6000 pounds will be phased-in to the new standard between 2004 and 2007. The heaviest LDTs will adopt a three-step approach, spanning from 2004 to 2009.

When it issued the Tier II standards, EPA also set new standards for sulfur levels in gasoline. Gasoline suppliers must meet an average sulfur level of 30 ppm by 2005, down from the current average of 300 ppm. The new sulfur levels will ensure the effectiveness of low emission-control technologies in vehicles. Auto makers and refiners will be allowed to meet these standards by averaging across the entire vehicle fleet and gasoline pool.

Pb emissions from on-road vehicles, which peaked in the early 1970s, have steadily decreased as the result of a series of regulatory actions that progressively reduced the Pb content of all gasoline. EPA mandates reduced the Pb content of gasoline dramatically, from an average of 1.0 gram per gallon (gpg) to 0.5 gpg on July 1, 1985, and still further to 0.1 gpg on January 1, 1986. In addition, as part of EPA's overall automotive emission control program, unleaded gasoline was introduced in 1975 for use in automobiles equipped with catalytic control devices, which help reduce CO, VOC, and NO_x emissions. In 1975, unleaded gasoline's share of the total gasoline market totaled 13 percent. By 1982 this share had climbed to approximately 50 percent, and by 1996 (due to the CAAA prohibition on the use of leaded gasoline in highway vehicles after December 31, 1995) unleaded gasoline accounted for 100 percent of the total gasoline market.

Table A-6 (see Appendix A) shows that Pb emissions decreased dramatically between 1990 and 1991. This decrease is the result of large changes in the values for Pb in gasoline. Since the prohibition on Pb in gasoline did not officially begin until January 1, 1996, the reductions calculated for 1991 and later are primarily the result of limited data on trace Pb levels in gasoline for these years. Therefore, the full reduction that begins in 1991 may actually occur several years later.

Pb emissions from on-road vehicles have fallen significantly since the introduction of these regulations, and Pb emissions from on-road vehicles now account for less than 1 percent of national Pb emissions, down substantially from almost 82 percent of national emissions in 1980.

In an effort to reduce SO_2 and PM (as sulfate particles) emissions from on-road vehicles, EPA published a regulation on August 21, 1990, that governs desulfurization of diesel motor fuel. This regulation states that as of October 1, 1993, all diesel fuel that contains a concentration of sulfur in excess of 0.05 percent by weight or that fails to meet a minimum cetane index of 40 cannot be used in motor vehicles.[5] Since implementation of these desulfurization regulations, EPA has found that SO_2 emissions from diesel motor vehicles are reduced by approximately 75 percent.

In 1940, on-road vehicles accounted for just over 1 percent of nonfugitive dust PM_{10} emissions. Although the 1998 emissions from on-road vehicles represent 9 percent of the total national PM_{10} emissions from nonfugitive dust sources, PM_{10} emissions from on-road vehicles in1998 are approximately the same as those in 1940.

Absent regulation, it is reasonable to assume that a decrease in the price of gasoline will result in greater VMT, increased fuel use, and greater emissions, all other factors remaining unchanged. However, overall on-road vehicle emissions actually declined from 1970 to 1998, despite the fact that fuel use increased approximately 50 percent, VMT increased over 100 percent, and real gasoline prices decreased 17 percent during this same time period.[1] These trends indicate the success of regulations in reducing emissions from on-road vehicles.

3.4.4 How Have Emissions in the Non-road Engines and Vehicle Categories Changed?

Unlike emissions trends for on-road vehicles, emissions of CO, NO_x, and VOC from non-road engines and vehicles increased steadily from 1940 to 1996, with slight reductions in CO and VOC emissions over the past 2 years. SO_2 emissions declined by 97 percent from 1940 to 1970, but have since risen again, to about one third of 1940 levels. PM_{10} emissions declined significantly from 1940 to 1960, rose slightly in the period from 1960 to 1990, and have declined slightly since 1990. $PM_{2.5}$ emissions have remained relatively level for the past 8 years. Pb emissions declined approximately 91 percent between 1970 and 1985, and they have continued to decline slightly since 1985. NH_3 emissions from non-road engines and vehicle over the past 9 years are quite negligible.

Non-road engines and vehicles contributed 9 percent of total national CO emissions in 1940, with emissions from railroad locomotives accounting for approximately 51 percent of this amount. CO emissions from non-road vehicles and engines have increased 90 percent from 1940 levels and now account for 22 percent of the national total, but now non-road gasoline equipment engines are the predominant sources of non-road CO emissions.

In 1900, non-road engines and vehicles accounted for 4 percent of total national VOC emissions, of which railroad emissions contributed 99 percent. Railroad VOC emissions peaked in 1920 at 20 percent of the national total and have decreased since then to less than 1 percent currently. Although railroad emissions decreased, emissions from non-road engines and vehicles increased 216 percent during the 1940 to 1998 period. As a result, emissions from non-road engines and vehicles as a percentage of the national total climbed from approximately 5 percent in 1940 to approximately 14 percent in 1998.

Similarly to on-road vehicle NO_x emissions trends, emissions from non-road engines and vehicles increased over the period from 1940 to 1998. To help slow this growth in emissions, EPA established emission control measures (Tier I standards) for new non-road diesel engines in certain horsepower categories. These standards began to take effect in 1996, with full phase-in for all horsepower categories scheduled for 2000. These controls should help reduce the amount of NO_x emissions emitted by these sources.

In 1940, SO_2 and PM_{10} emissions from non-road vehicles and engines both accounted for approximately 16 percent, respectively, of total national emissions for these two pollutants. Railroads contributed significantly to total 1940 SO_2 and PM_{10} emissions. From 1940 to 1970, SO_2 and PM_{10} emissions from railroads decreased by 99 percent as a result of the obsolescence of coal-fired locomotives. By 1998, non-road engines and vehicles represented only 1 percent of the total 1998 national PM_{10} emissions (16 percent of nonfugitive dust sources). While PM_{10} emissions from non-road engines and vehicles declined, so did PM_{10} emissions from most other nonfugitive dust sources.

3.4.5 How Have Emissions in the Miscellaneous Categories Changed?

In 1940, CO emissions from "miscellaneous other combustion - forest wildfires" accounted for 27 percent of total national CO emissions. Although relatively erratic from year to year due to the uncontrolled nature of wildfires, wildfire CO emissions declined from 1940 levels to only 3 percent of total national CO emissions in 1998. Similarly, annual PM_{10} emissions from wildfires vary depending upon the incidence of wildfires and upon weather conditions in forested areas.

Miscellaneous source emissions accounted for 13 percent of the total 1940 NO_x emissions. In 1998, the total emissions for the miscellaneous sources accounted for slightly more than 1 percent of national NO_x emissions.

In 1900, emissions from the miscellaneous sources category represented 24 percent of total VOC emissions. By 1998 they accounted for only 4 percent of national VOC emissions. With regard to SO_2 emissions, miscellaneous sources accounted for less than 3 percent of total national SO_2 emissions in 1940. By 1998, they contributed less than 0.1 percent of national SO_2 emissions. Pb emissions from other/miscellaneous sources account for a negligible amount of national Pb emissions. Meanwhile, miscellaneous emissions account for a substantial percentage of NH_3 emissions. From 1990 to 1998, emissions from miscellaneous sources rose 13 percent, and they accounted for 86 percent of total national NH_3 emissions in both 1990 and 1998.

3.5 HOW HAVE EMISSIONS IN THE FUGITIVE DUST CATEGORIES CHANGED?

Fugitive dust source emission estimates were first presented in the *1991 Trends* report. At that time, EPA based its emission estimates upon old emission factors and limited data. The methods EPA used to produce the estimates relied on State-level default data for most source categories. In the 1997 Trends report, EPA revised the methods used to produce post-1989 estimates in order to reflect improved emission factors, improved activity data, or both.

For several source categories, the methodology for estimating fugitive dust emissions utilizes meteorological data such as the number of days with greater than 0.01 inches of precipitation and average monthly wind speed. These data can vary significantly from year-to-year, resulting in highly variable emissions.

PM_{10} and $PM_{2.5}$ fugitive dust emissions can be determined from Tables 3-5 and 3-6 respectively. The categories that comprise the fugitive dust emission categories are identified in Chapter 1, section 1.4. As previously noted, estimates of PM_{10} fugitive dust prior to 1989 were based on crude methodologies and should be strongly discounted. PM_{10} emissions from fugitive dust sources decreased by 24 percent from 1985 to 1998 due primarily to the changes in emission methodologies for several of the fugitive dust sources, but also due to holding wind erosion constant from 1996 forward.

For 1998, EPA estimates total national fugitive dust PM_{10} and $PM_{2.5}$ emissions to be approximately 8 and 2 times higher, respectively, than total national nonfugitive PM_{10} and $PM_{2.5}$ emissions.

3.6 REFERENCES

1. "Energy Statistics Sourcebook," Ninth Edition, Pennwell Publishing. August 1994.
2. "Electric Power Monthly," Energy Information Administration, U.S. Department of Energy, Washington, DC, various editions.
3. "1995 Compliance Results," Acid Rain Program, EPA-430/R-96-012, Office of Air and Radiation, U.S. Environmental Protection Agency, Washington, DC. July 1996.
4. "Cement," *Minerals Yearbook*, U.S. Department of Interior, Bureau of Mines, Washington, DC, various years.
5. "Development of an Industrial SO_2 Emissions Inventory Baseline and 1995 Report to Congress," U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1994.

Table 3-1. Total National Emissions of Carbon Monoxide, 1940 through 1998

(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1996	1998
FUEL COMB. ELEC. UTIL.	4	110	110	237	322	363	391	417
FUEL COMB. INDUSTRIAL	435	549	661	770	750	879	1,155	1,115
FUEL COMB. OTHER	14,890	10,656	6,250	3,625	6,230	4,269	4,603	3,843
Residential Wood	11,279	7,716	4,743	2,932	5,992	3,781	4,200	3,452
CHEMICAL & ALLIED PRODUCT MFG	4,190	5,844	3,982	3,397	2,151	1,183	1,100	1,129
Other Chemical Mfg	4,139	5,760	3,775	2,866	1,417	854	870	893
carbon black mfg	4,139	5,760	3,775	2,866	1,417	798	841	863
METALS PROCESSING	2,750	2,910	2,866	3,644	2,246	2,640	1,429	1,495
Nonferrous Metals Processing	36	118	326	652	842	436	442	446
Ferrous Metals Processing	2,714	2,792	2,540	2,991	1,404	2,163	944	1,006
basic oxygen furnace	NA	NA	23	440	80	594	117	126
PETROLEUM & RELATED INDUSTRIES	221	2,651	3,086	2,179	1,723	333	356	368
Oil & Gas Production	NA	NA	NA	NA	NA	38	26	27
Petroleum Refineries & Related Industries	221	2,651	3,086	2,168	1,723	291	322	334
fcc units	210	2,528	2,810	1,820	1,680	284	311	322
OTHER INDUSTRIAL PROCESSES	114	231	342	620	830	537	600	632
Wood, Pulp & Paper, & Publishing Products	110	220	331	610	798	473	391	416
sulfate pulping: rec. furnace/evaporator	NA	NA	NA	NA	NA	370	305	325
SOLVENT UTILIZATION	NA	NA	NA	NA	NA	5	2	2
STORAGE & TRANSPORT	NA	NA	NA	NA	NA	76	78	80
WASTE DISPOSAL & RECYCLING	3,630	4,717	5,597	7,059	2,300	1,079	1,127	1,154
Incineration	2,202	2,711	2,703	2,979	1,246	372	404	413
residential	716	824	972	1,107	945	294	330	336
Open Burning	1,428	2,006	2,894	4,080	1,054	706	717	735
residential	NA	NA	NA	NA	NA	509	515	524
ON-ROAD VEHICLES	30,121	45,196	64,266	88,034	78,049	57,848	53,262	50,386
Light-Duty Gas Vehicles & Motorcycles	22,237	31,493	47,679	64,031	53,561	37,407	28,732	27,039
light-duty gas vehicles	22,232	31,472	47,655	63,846	53,342	37,198	28,543	26,848
Light-Duty Gas Trucks	3,752	6,110	7,791	16,570	16,137	13,816	19,271	18,726
light-duty gas trucks 1	2,694	4,396	5,591	10,102	10,395	8,415	11,060	10,826
light-duty gas trucks 2	1,058	1,714	2,200	6,468	5,742	5,402	8,211	7,900
Heavy-Duty Gas Vehicles	4,132	7,537	8,557	6,712	7,189	5,360	3,766	3,067
Diesels	NA	54	239	721	1,161	1,265	1,493	1,554
heavy-duty diesel vehicles	NA	54	239	721	1,139	1,229	1,453	1,514
NON-ROAD ENGINES AND VEHICLES	8,051	11,610	11,575	11,970	14,489	18,191	20,232	19,914
Non-Road Gasoline	3,777	7,331	8,753	10,946	12,760	15,394	17,074	16,812
industrial	780	1,558	1,379	535	709	723	592	563
lawn & garden	NA	NA	NA	5,899	6,764	8,237	9,305	9,024
light commercial	NA	NA	NA	1,905	2,095	2,877	3,514	3,566
recreational marine vessels	60	120	518	1,763	1,990	2,117	2,142	2,156
Non-Road Diesel	32	53	65	430	829	1,098	1,282	1,180
construction	20	43	40	254	479	662	794	728
farm	12	10	17	16	174	166	176	163
Aircraft	4	934	1,764	506	743	904	949	955
Railroads	4,083	3,076	332	65	96	121	112	115
MISCELLANEOUS	29,210	18,135	11,010	7,909	8,344	11,122	11,144	8,920
Other Combustion	29,210	18,135	11,010	7,909	8,344	11,122	11,144	8,919
TOTAL ALL SOURCES	93,616	102,609	109,745	129,444	117,434	98,523	95,480	89,455

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.
"Other" categories may contain emissions that could not be accurately allocated to specific source categories.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-2. Total National Emissions of Nitrogen Oxides, 1940 through 1998
(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1996	1998
FUEL COMB. ELEC. UTIL.	660	1,316	2,536	4,900	7,024	6,663	6,057	6,103
Coal	467	1,118	2,038	3,888	6,123	5,642	5,542	5,395
bituminous	255	584	1,154	2,112	3,439	4,532	3,748	3,622
Oil	193	198	498	1,012	901	221	103	208
residual	6	23	8	40	39	207	101	206
distillate	187	175	490	972	862	14	2	2
Gas	NA	NA	NA	NA	NA	565	265	344
natural	NA	NA	NA	NA	NA	565	264	342
FUEL COMB. INDUSTRIAL	2,543	3,192	4,075	4,325	3,555	3,035	3,072	2,969
Coal	2,012	1,076	782	771	444	585	567	548
Oil	122	237	239	332	286	265	231	216
Gas	365	1,756	2,954	3,060	2,619	1,182	1,184	1,154
natural	337	1,692	2,846	3,053	2,469	967	978	943
Internal Combustion	NA	NA	NA	NA	NA	874	967	932
FUEL COMB. OTHER	529	647	760	836	741	1,196	1,224	1,117
Commercial/Institutional Gas	7	18	55	120	131	200	238	234
Residential Other	177	227	362	439	356	780	783	700
natural gas	20	50	148	242	238	449	481	410
CHEMICAL & ALLIED PRODUCT MFG	6	63	110	271	213	168	146	152
METALS PROCESSING	4	110	110	77	65	97	83	88
PETROLEUM & RELATED INDUSTRIES	105	110	220	240	72	153	134	138
OTHER INDUSTRIAL PROCESSES	107	93	131	187	205	378	386	408
Mineral Products	105	89	123	169	181	270	286	303
cement mfg	32	55	78	97	98	151	172	182
SOLVENT UTILIZATION	NA	NA	NA	NA	NA	1	2	2
STORAGE & TRANSPORT	NA	NA	NA	NA	NA	3	7	7
WASTE DISPOSAL & RECYCLING	110	215	331	440	111	91	95	97
ON-ROAD VEHICLES	1,330	2,143	3,982	7,390	8,621	7,089	7,848	7,765
Light-Duty Gas Vehicles & Motorcycles	970	1,415	2,607	4,158	4,421	3,220	2,979	2,849
light-duty gas vehicles	970	1,415	2,606	4,156	4,416	3,208	2,967	2,837
Light-Duty Gas Trucks	204	339	525	1,278	1,408	1,256	1,950	1,917
light-duty gas trucks 1	132	219	339	725	864	784	1,156	1,132
light-duty gas trucks 2	73	120	186	553	544	472	794	785
Heavy-Duty Gas Vehicles	155	296	363	278	300	326	329	323
Diesels	NA	93	487	1,676	2,493	2,287	2,591	2,676
heavy-duty diesel vehicles	NA	93	487	1,676	2,463	2,240	2,544	2,630
NON-ROAD ENGINES AND VEHICLES	991	1,538	1,443	1,931	3,529	4,804	5,167	5,280
Non-Road Gasoline	122	249	312	85	101	120	132	159
Non-Road Diesel	103	187	247	1,109	2,125	2,513	2,786	2,809
construction	70	158	157	436	843	1,102	1,218	1,230
farm	33	29	50	350	926	898	1,001	999
Aircraft	NA	2	4	72	106	158	167	168
Marine Vessels	109	108	108	171	467	943	985	1,008
Railroads	657	992	772	495	731	929	922	947
MISCELLANEOUS	990	665	441	330	248	369	452	328
TOTAL ALL SOURCES	7,374	10,093	14,140	20,928	24,384	24,049	24,676	24,454

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.
"Other" categories may contain emissions that could not be accurately allocated to specific source categories.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-3. Total National Emissions of Volatile Organic Compounds, 1940 through 1998 (thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1996	1998
FUEL COMB. ELEC. UTIL.	2	9	9	30	45	47	49	54
FUEL COMB. INDUSTRIAL	108	98	106	150	157	182	166	161
FUEL COMB. OTHER	1,867	1,336	768	541	848	776	821	678
Residential Wood	1,410	970	563	460	809	718	759	620
CHEMICAL & ALLIED PRODUCT MFG	884	1,324	991	1,341	1,595	634	388	396
METALS PROCESSING	325	442	342	394	273	122	72	75
PETROLEUM & RELATED INDUSTRIES	571	548	1,034	1,194	1,440	612	488	496
OTHER INDUSTRIAL PROCESSES	130	184	202	270	237	401	428	450
SOLVENT UTILIZATION	1,971	3,679	4,403	7,174	6,584	5,750	5,506	5,278
Degreasing	168	592	438	707	513	744	606	457
Graphic Arts	114	310	199	319	373	274	296	311
Dry Cleaning	42	153	126	263	320	215	157	169
petroleum solvent	NA	NA	NA	NA	NA	104	92	99
Surface Coating	1,058	2,187	2,128	3,570	3,685	2,523	2,389	2,224
industrial adhesives	14	41	29	52	55	390	356	160
architectural	284	NA	412	442	477	495	484	491
Nonindustrial	490	NA	1,189	1,674	1,002	1,900	1,957	2,012
cutback asphalt	328	NA	789	1,045	323	199	135	144
pesticide application	73	NA	193	241	241	258	386	405
adhesives	NA	NA	NA	NA	NA	361	307	313
consumer solvents	NA	NA	NA	NA	NA	1,083	1,081	1,099
STORAGE & TRANSPORT	639	1,218	1,762	1,954	1,975	1,495	1,286	1,324
Bulk Terminals & Plants	185	361	528	599	517	359	211	217
area source: gasoline	158	307	449	509	440	282	163	167
Petroleum & Petroleum Product Storage	148	218	304	300	306	157	172	178
Petroleum & Petroleum Product Transport	57	100	115	92	61	151	118	122
Service Stations: Stage I	117	251	365	416	461	300	312	320
Service Stations: Stage II	130	283	437	521	583	433	397	409
WASTE DISPOSAL & RECYCLING	990	1,104	1,546	1,984	758	986	423	433
ON-ROAD VEHICLES	4,817	7,251	10,506	12,972	8,979	6,313	5,490	5,325
Light-Duty Gas Vehicles & Motorcycles	3,647	5,220	8,058	9,193	5,907	3,947	2,875	2,832
light-duty gas vehicles	3,646	5,214	8,050	9,133	5,843	3,885	2,839	2,793
Light-Duty Gas Trucks	672	1,101	1,433	2,770	2,059	1,622	2,060	2,015
Heavy-Duty Gas Vehicles	498	908	926	743	611	432	293	257
Diesels	NA	22	89	266	402	312	263	222
NON-ROAD ENGINES AND VEHICLES	778	1,213	1,215	1,878	2,312	2,545	2,664	2,461
Non-Road Gasoline	208	423	526	1,564	1,787	1,889	1,982	1,794
lawn & garden	NA	NA	NA	511	583	700	771	638
recreational marine vessels	16	32	124	736	830	784	777	780
Non-Road Diesel	12	20	23	187	327	390	422	405
construction	6	15	13	94	135	181	206	199
farm	6	5	8	39	138	126	120	111
Aircraft	3	110	220	97	146	180	177	177
NATURAL SOURCES	NA	NA	NA	NA	NA	14	14	14
MISCELLANEOUS	4,079	2,530	1,573	1,101	1,134	1,059	940	772
Other Combustion	4,079	2,530	1,573	1,101	1,134	1,049	891	721
TOTAL ALL SOURCES	17,161	20,936	24,459	30,982	26,336	20,936	18,736	17,917

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.
"Other" categories may contain emissions that could not be accurately allocated to specific source categories.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-4. Total National Emissions of Sulfur Dioxide, 1940 through 1998

(thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1996	1998
FUEL COMB. ELEC. UTIL.	***2,427***	***4,515***	***9,263***	***17,398***	***17,469***	***15,909***	***12,631***	***13,217***
Coal	2,276	4,056	8,883	15,799	16,073	15,220	12,137	12,426
bituminous	*1,359*	*2,427*	*5,367*	*9,574*	*NA*	*13,371*	*8,931*	*9,368*
subbituminous	*668*	*1,196*	*2,642*	*4,716*	*NA*	*1,415*	*2,630*	*2,440*
anthracite & lignite	*249*	*433*	*873*	*1,509*	*NA*	*434*	*576*	*618*
Oil	151	459	380	1,598	1,395	639	436	730
residual	*146*	*453*	*375*	*1,578*	*NA*	*629*	*430*	*726*
FUEL COMB. INDUSTRIAL	***6,060***	***5,725***	***3,864***	***4,568***	***2,951***	***3,550***	***3,022***	***2,895***
Coal	5,188	4,423	2,703	3,129	1,527	1,914	1,465	1,415
bituminous	*3,473*	*2,945*	*1,858*	*2,171*	*1,058*	*1,050*	*1,031*	*1,000*
Oil	554	972	922	1,229	1,065	927	844	773
residual	*397*	*721*	*663*	*956*	*851*	*687*	*637*	*568*
distillate	*9*	*49*	*42*	*98*	*85*	*198*	*187*	*184*
Gas	145	180	189	140	299	543	556	558
FUEL COMB. OTHER	***3,642***	***3,964***	***2,319***	***1,490***	***971***	***831***	***667***	***609***
Commercial/Institutional Coal	695	1,212	154	109	110	212	177	194
Commercial/Institutional Oil	407	658	905	883	637	425	338	275
Residential Other	2,517	2,079	1,250	492	211	175	131	121
bituminous/subbituminous coal	*2,267*	*1,758*	*868*	*260*	*43*	*30*	*17*	*18*
CHEMICAL & ALLIED PRODUCT MFG	**215**	**427**	**447**	**591**	**280**	**297**	**291**	**299**
Inorganic Chemical Mfg	215	427	447	591	271	214	204	210
sulfur compounds	*215*	*427*	*447*	*591*	*271*	*211*	*202*	*208*
METALS PROCESSING	***3,309***	***3,747***	***3,986***	***4,775***	***1,842***	***726***	***429***	***444***
Nonferrous Metals Processing	2,760	3,092	3,322	4,060	1,279	517	283	288
copper	*2,292*	*2,369*	*2,772*	*3,507*	*1,080*	*323*	*114*	*119*
lead	*80*	*95*	*57*	*77*	*34*	*129*	*111*	*110*
Ferrous Metals Processing	550	655	664	715	562	186	128	139
PETROLEUM & RELATED INDUSTRIES	***224***	***340***	***676***	***881***	***734***	***430***	***337***	***345***
Oil & Gas Production	NA	14	114	111	157	122	95	96
natural gas	*NA*	*14*	*114*	*111*	*157*	*120*	*95*	*95*
Petroleum Refineries & Related Industries	224	326	562	770	577	304	234	241
fluid catalytic cracking units	*220*	*242*	*383*	*480*	*330*	*183*	*153*	*158*
OTHER INDUSTRIAL PROCESSES	***334***	***596***	***671***	***846***	***918***	***399***	***350***	***370***
Wood, Pulp & Paper, & Publishing Products	NA	43	114	169	223	116	102	108
Mineral Products	334	553	557	677	694	275	230	243
cement mfg	*318*	*522*	*524*	*618*	*630*	*181*	*147*	*156*
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***NA***	***NA***	***0***	***1***	***1***
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***NA***	***NA***	***7***	***3***	***3***
WASTE DISPOSAL & RECYCLING	***3***	***3***	***10***	***8***	***33***	***42***	***41***	***42***
ON-ROAD VEHICLES	***3***	***103***	***114***	***411***	***521***	***542***	***316***	***326***
Light-Duty Gas Vehicles & Motorcycles	NA	NA	NA	132	159	138	127	130
Diesels	NA	NA	NA	231	303	337	83	85
NON-ROAD ENGINES AND VEHICLES	***3,190***	***2,392***	***321***	***83***	***175***	***916***	***1,016***	***1,084***
Marine Vessels	215	215	105	43	117	251	237	261
Railroads	2,975	2,174	215	36	53	122	111	114
MISCELLANEOUS	***545***	***545***	***554***	***110***	***11***	***12***	***17***	***12***
Other Combustion	545	545	554	110	11	12	17	12
Fugitive Dust				NA	NA	0	0	0
TOTAL ALL SOURCES	**19,952**	**22,357**	**22,227**	**31,161**	**25,905**	**23,660**	**19,121**	**19,647**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate. Zero values represent less than 500 short tons/year.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

The 1985 fuel combustion, electric utility category is based on the National Allowance Data Base Version 2.11, Acid Rain Division, U.S. EPA, released March 23, 1993. Allocations at the Tier 3 levels are approximations only and are based on the methodology described in section 6.0, paragraph 6.2.1.1.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-5. Total National Emissions of Directly Emitted Particulate Matter (PM_{10}), 1940 through 1998 (thousand short tons)

Source Category	1940	1950	1960	1970	1980	1990	1996	1998
FUEL COMB. ELEC. UTIL.	962	1,467	2,117	1,775	879	295	287	302
Coal	954	1,439	2,092	1,680	796	265	264	273
bituminous	573	865	1,288	1,041	483	188	195	200
FUEL COMB. INDUSTRIAL	708	604	331	641	679	270	255	245
Coal	549	365	146	83	18	84	77	74
Other	120	160	103	441	571	87	77	74
FUEL COMB. OTHER	2,338	1,674	1,113	455	887	631	632	544
Residential Wood	1,716	1,128	850	384	818	501	503	411
CHEMICAL & ALLIED PRODUCT MFG	330	455	309	235	148	77	63	65
METALS PROCESSING	1,208	1,027	1,026	1,316	622	214	164	171
Nonferrous Metals Processing	588	346	375	593	130	50	35	37
copper	217	105	122	343	32	14	7	7
Ferrous Metals Processing	246	427	214	198	322	155	108	112
primary	86	98	51	31	271	128	86	91
PETROLEUM & RELATED INDUSTRIES	366	412	689	286	138	55	32	32
OTHER INDUSTRIAL PROCESSES	3,996	6,954	7,211	5,832	1,846	583	327	339
Agriculture, Food, & Kindred Products	784	696	691	485	402	73	61	61
country elevators	299	307	343	257	258	9	6	6
terminal elevators	351	258	224	147	86	6	2	2
Wood, Pulp & Paper, & Publishing Products	511	798	958	727	183	105	78	82
sulfate (kraft) pulping	470	729	886	668	142	73	43	45
Mineral Products	2,701	5,460	5,563	4,620	1,261	367	156	162
cement mfg	1,363	1,998	2,014	1,731	417	190	21	22
stone quarrying/processing	482	663	1,039	957	421	54	24	24
SOLVENT UTILIZATION	NA	NA	NA	NA	NA	4	6	6
STORAGE & TRANSPORT	NA	NA	NA	NA	NA	102	90	94
Bulk Materials Storage	NA	NA	NA	NA	NA	100	87	91
WASTE DISPOSAL & RECYCLING	392	505	764	999	273	271	304	310
Open Burning	220	333	544	770	198	206	211	215
residential	220	333	544	770	198	195	194	197
ON-ROAD VEHICLES	210	314	554	443	397	336	282	257
Diesels	NA	9	15	136	208	235	177	152
heavy-duty diesel vehicles	NA	9	15	136	194	224	168	144
NON-ROAD ENGINES AND VEHICLES	2,480	1,788	201	220	398	489	457	461
Non-Road Diesel	1	16	22	281	439	301	297	301
construction	0	12	12	102	148	149	147	150
farm	0	4	7	140	239	78	72	69
Railroads	2,464	1,742	110	25	37	53	27	27
NATURAL SOURCES	NA	NA	NA	NA	NA	2,092	5,307	5,307
*Geogenic - wind erosion**	NA	NA	NA	NA	NA	2,092	5,307	5,307
MISCELLANEOUS	2,968	1,934	1,244	839	852	24,542	24,836	26,609
Agriculture & Forestry	NA	NA	NA	NA	NA	5,292	4,905	4,970
*agricultural crops***	NA	NA	NA	NA	NA	4,745	4,328	4,366
*agricultural livestock***	NA	NA	NA	NA	NA	547	577	603
Other Combustion	2,968	1,934	1,244	839	852	1,181	1,254	1,018
Fugitive Dust	NA	NA	NA	NA	NA	18,069	18,675	20,619
*unpaved roads***	NA	NA	NA	NA	NA	11,234	12,059	12,668
*paved roads***	NA	NA	NA	NA	NA	2,248	2,390	2,618
*construction***				NA	NA	4,249	3,578	4,545
TOTAL ALL SOURCES	15,957	17,133	15,558	13,042	7,119	29,962	33,041	34,741

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate. Zero values represent less than 500 short tons/year.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

* Although geogenic wind erosion emissions are included in this summary table, it is very difficult to interpret annual estimates of PM emissions from this source category in a meaningful way, owing to the highly episodic nature of the events that contribute to these emissions.

** These are the main source categories of PM crustal material emissions. A report by the Desert Research Institute found that about 75% of these emissions are within 2 m of the ground at the point they are measured. Thus, most of them are likely to be removed or deposited within a few km of their release, depending on atmospheric turbulence, temperature, soil moisture, availability of horizontal and vertical surfaces for impaction and initial suspension energy. This is consistent with the generally small amount of crustal materials found on speciated ambient samples. (See reference 6 in Chapter 2.)

Table 3-6. Total National Emissions of Directly Emitted Particulate Matter (PM$_{2.5}$), 1990 through 1998 (thousand short tons)

Source Category	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	121	105	106	112	108	107	156	160	165
Coal	97	85	87	90	86	86	133	135	138
bituminous	59	53	53	57	54	52	88	89	91
FUEL COMB. INDUSTRIAL	177	151	159	172	183	203	166	161	160
Other	73	58	59	69	60	59	62	60	60
FUEL COMB. OTHER	611	638	662	568	550	589	537	466	466
Residential Wood	501	535	558	464	446	484	433	358	357
CHEMICAL & ALLIED PRODUCT MFG	47	43	45	41	49	42	38	39	39
METALS PROCESSING	157	197	198	125	125	134	108	113	112
Ferrous Metals Processing	121	89	83	86	86	92	69	72	72
primary	103	72	66	68	68	74	53	56	56
PETROLEUM & RELATED INDUSTRIES	27	24	24	22	22	22	18	18	18
OTHER INDUSTRIAL PROCESSES	284	264	259	260	256	256	178	184	187
Wood, Pulp & Paper, & Publishing Products	77	61	59	59	57	60	54	56	57
Mineral Products	144	134	135	136	133	134	83	87	88
SOLVENT UTILIZATION	4	4	5	6	6	5	5	5	5
STORAGE & TRANSPORT	42	42	50	46	43	42	31	32	32
WASTE DISPOSAL & RECYCLING	234	238	239	288	271	247	234	236	238
Open Burning	187	190	192	195	196	197	186	188	190
residential	177	179	181	183	184	185	176	177	179
ON-ROAD VEHICLES	275	286	280	257	256	231	221	211	197
Diesels	212	221	216	192	190	169	157	147	134
hddv	203	212	206	183	182	161	149	140	127
NON-ROAD ENGINES AND VEHICLES	432	432	433	427	424	403	410	411	413
Non-Road Diesel	277	275	273	273	272	272	274	275	277
construction	137	136	136	135	134	134	135	136	138
farm	71	71	70	69	68	67	66	65	63
NATURAL SOURCES	314	312	334	76	324	172	796	796	796
Geogenic - wind erosion*	314	312	334	76	324	172	796	796	796
MISCELLANEOUS	5,234	5,004	4,854	4,926	5,360	4,725	5,298	5,652	5,549
Agriculture & Forestry	1,031	1,019	976	887	941	952	952	964	964
*agricultural crops***	949	937	893	803	856	867	866	875	873
*agricultural livestock***	82	83	83	84	85	85	87	90	91
Other Combustion	1,037	807	666	693	913	734	1,040	1,150	882
Fugitive Dust	3,166	3,178	3,213	3,346	3,506	3,038	3,304	3,535	3,701
*unpaved roads***	1,687	1,684	1,642	1,718	1,709	1,559	1,819	1,892	1,912
*paved roads***	562	600	606	616	634	585	598	635	655
*construction***	850	818	892	930	1,049	777	750	857	968
TOTAL ALL SOURCES	**7,958**	**7,739**	**7,648**	**7,327**	**7,975**	**7,179**	**8,194**	**8,483**	**8,379**

Note(s): NA = not available. Zero values represent less than 500 short tons/year.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

* Although geogenic wind erosion emissions are included in this summary table, it is very difficult to interpret annual estimates of PM emissions from this source category in a meaningful way, owing to the highly episodic nature of the events that contribute to these emissions.

* These are the main source categories of PM crustal material emissions. A report by the Desert Research Institute found that about 75% of these emissions are within 2 m of the ground at the point they are measured. Thus, most of them are likely to be removed or deposited within a few km of their release, depending on atmospheric turbulence, temperature, soil moisture, initial suspension energy and availability of horizontal and vertical surfaces for impaction. This is consistent with the generally small amount of crustal materials found on speciated ambient samples. (See reference 6 in Chapter 2.)

For a complete understanding of PM$_{2.5}$ emissions, one should also consider the emissions of SO_2, NO_x, and NH_3. These gases react in the atmosphere to form ammonium sulfate and ammonium nitrate fine particles; also, some organic particles are formed from VOCs. These "secondary" fine particles (in contrast to the directly emitted particles from combustion and fugitive dust) can comprise as much as half the PM$_{2.5}$ measured in the United States.[7] Source apportionment studies exist to help elucidate the role of primary PM (reflected in the NET) and secondary PM.

Table 3-7. Total National Emissions of Lead, 1970 through 1998
(short tons)

Source Category	1970	1975	1980	1985	1990	1996	1998
FUEL COMB. ELEC. UTIL.	***327***	***230***	***129***	***64***	***64***	***61***	***68***
Coal	300	189	95	51	46	53	54
bituminous	*181*	*114*	*57*	*31*	*28*	*32*	*33*
Oil	28	41	34	13	18	8	14
FUEL COMB. INDUSTRIAL	***237***	***75***	***60***	***30***	***18***	***16***	***19***
Coal	218	60	45	22	14	13	13
bituminous	*146*	*40*	*31*	*15*	*10*	*9*	*9*
Oil	19	16	14	8	3	3	5
FUEL COMB. OTHER	***10,052***	***10,042***	***4,111***	***421***	***418***	***415***	***416***
Misc. Fuel Comb. (Except Residential)	10,000	10,000	4,080	400	400	400	400
CHEMICAL & ALLIED PRODUCT MFG	***103***	***120***	***104***	***118***	***136***	***167***	***175***
Inorganic Chemical Mfg	103	120	104	118	136	167	175
lead oxide and pigments	*103*	*120*	*104*	*118*	*136*	*167*	*175*
METALS PROCESSING	***24,224***	***9,923***	***3,026***	***2,097***	***2,170***	***2,055***	***2,098***
Nonferrous Metals Processing	15,869	7,192	1,826	1,376	1,409	1,333	1,371
primary lead production	*12,134*	*5,640*	*1,075*	*874*	*728*	*588*	*628*
primary copper production	*242*	*171*	*20*	*19*	*19*	*22*	*23*
primary zinc production	*1,019*	*224*	*24*	*16*	*9*	*13*	*13*
secondary lead production	*1,894*	*821*	*481*	*288*	*449*	*514*	*505*
secondary copper production	*374*	*200*	*116*	*70*	*75*	*76*	*83*
lead battery manufacture	*41*	*49*	*50*	*65*	*78*	*103*	*117*
lead cable coating	*127*	*55*	*37*	*43*	*50*	*16*	*1*
Ferrous Metals Processing	7,395	2,196	911	577	576	529	542
coke manufacturing	*11*	*8*	*6*	*3*	*4*	*0*	*0*
ferroalloy production	*219*	*104*	*13*	*7*	*18*	*8*	*4*
iron production	*266*	*93*	*38*	*21*	*18*	*18*	*19*
steel production	*3,125*	*1,082*	*481*	*209*	*138*	*160*	*173*
gray iron production	*3,773*	*910*	*373*	*336*	*397*	*343*	*345*
Metals Processing NEC	960	535	289	144	185	193	186
metal mining	*353*	*268*	*207*	*141*	*184*	*192*	*186*
OTHER INDUSTRIAL PROCESSES	***2,028***	***1,337***	***808***	***316***	***169***	***51***	***54***
Mineral Products	540	217	93	43	26	29	31
cement manufacturing	*540*	*217*	*93*	*43*	*26*	*29*	*31*
Miscellaneous Industrial Processes	1,488	1,120	715	273	143	22	23
WASTE DISPOSAL & RECYCLING	***2,200***	***1,595***	***1,210***	***871***	***804***	***609***	***620***
Incineration	2,200	1,595	1,210	871	804	609	620
municipal waste	*581*	*396*	*161*	*79*	*67*	*76*	*75*
other	*1,619*	*1,199*	*1,049*	*792*	*738*	*534*	*546*
ON-ROAD VEHICLES	***171,961***	***130,206***	***60,501***	***18,052***	***421***	***19***	***19***
Light-Duty Gas Vehicles & Motorcycles	142,918	106,868	47,184	13,637	314	12	12
Light-Duty Gas Trucks	22,683	19,440	11,671	4,061	100	7	7
Heavy-Duty Gas Vehicles	6,361	3,898	1,646	354	7	0	0
NON-ROAD ENGINES AND VEHICLES	***9,737***	***6,130***	***4,205***	***921***	***776***	***505***	***503***
Non-Road Gasoline	8,340	5,012	3,320	229	158	0	0
Aircraft	1,397	1,118	885	692	619	505	503
TOTAL ALL SOURCES	220,869	159,659	74,153	22,890	4,975	3,899	3,973

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate. Zero values represent less than 500 short tons/year.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-8. Total National Emissions of Ammonia, 1990 through 1998
(thousand short tons)

Source Category	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	0	0	0	0	0	0	6	7	8
FUEL COMB. INDUSTRIAL	17	17	17	18	18	18	49	48	47
FUEL COMB. OTHER	8	8	8	8	8	8	7	7	6
CHEMICAL & ALLIED PRODUCT MFG	183	183	183	183	183	183	158	160	165
METALS PROCESSING	6	6	6	6	6	6	5	5	5
PETROLEUM & RELATED INDUSTRIES	43	43	43	43	43	43	34	35	35
OTHER INDUSTRIAL PROCESSES	38	38	39	39	40	40	43	44	44
SOLVENT UTILIZATION	0	0	0	0	0	0	0	0	0
STORAGE & TRANSPORT	0	0	0	0	0	0	1	1	1
WASTE DISPOSAL & RECYCLING	82	86	89	93	93	93	84	84	86
ON-ROAD VEHICLES	192	205	217	227	239	259	231	240	250
NON-ROAD ENGINES AND VEHICLES	6	7	7	7	7	7	9	10	10
NATURAL SOURCES	30	29	28	29	30	31	32	33	34
Biogenic	30	29	28	29	30	31	32	33	34
MISCELLANEOUS	3,727	3,770	3,814	3,869	3,924	3,979	4,113	4,163	4,244
Agriculture & Forestry	3,727	3,770	3,814	3,869	3,924	3,979	4,113	4,163	4,244
livestock agriculture	3,307	3,324	3,341	3,370	3,399	3,427	3,456	3,485	3,520
fertilizer application	420	446	473	499	525	551	657	678	724
TOTAL ALL SOURCES	4,331	4,390	4,449	4,521	4,589	4,665	4,772	4,837	4,935

Note(s): NA = not available. Zero values represent less than 500 short tons/year.
Categories displayed below Tier 1 do not sum to Tier 1 totals because they are intended to show major contributors.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table 3-9. Carbon Monoxide Federal Emission Standards, 1970 to 1991

	Emission Limit (grams of CO per mile)	
Model year	Light-duty Vehicles	Light-duty Trucks (0 to 6,000 lbs.)
1970-1971	23	
1972-1974	39	39
1975-1979	15	20[1]
1980-1991	3.4[2]	18[3],10[4]

Note(s):
[1] Standard applies for 1975-1978 model years.
[2] Certain vehicles were subject to a less stringent requirement of 7.0 grams per mile from model years 1980-1984.
[3] Standard applies for 1979-1983 model years.
[4] Standard applies for 1984-1991 model years.

The first vehicle standards were implemented by the Federal government in 1968 and were concentration based (ppm of exhaust for hydrocarbons and CO). The first mass based standards (g/mile) were in 1972.

Table 3-10. Nitrogen Oxide and Volatile Organic Compound Federal Emission Limits for Light-Duty Vehicles, 1972 to 1991

	Emission Limit (grams per mile)	
Model Year	NO_x	VOC[1]
1972-1974	3.0[2]	3.4
1975-1979	3.1[3], 2.0[4]	1.5
1980-1991	1.0[5]	0.41

Note(s):
[1] These are exhaust emission standards for VOC.
[2] Standard applies for 1973-1974 model years.
[3] Standard applies for 1975-1976 model years.
[4] Standard applies for 1977-1980 model years.
[5] Standard applies for 1981-1991 model years.

The first vehicle standards were implemented by the Federal government in 1968 and were concentration based (ppm of exhaust for hydrocarbons and CO). The first mass based standards (g/mile) were in 1972.

Table 3-11. Nitrogen Oxide and Volatile Organic Compound Federal Emission Limits for Light-Duty Trucks, 1972 to 1991

	Emission Limit (grams per mile)	
Model Year	**NO_x**	**VOC[1]**
1972-1974	3.0[2]	3.4
1975-1978	3.1[3]	2.0
1979-1984	2.3[4]	1.7
1985-1991	1.2[5,6]	0.8

Note(s):
[1] These are exhaust emission standards for VOC.
[2] Standard applies for 1973-1974 model years.
[3] Standard applies for 1975-1978 model years.
[4] Standard applies for 1979-1987 model years.
[5] Standard applies for 1988-1993 model years.
[6] Light-duty trucks with a loaded-vehicle weight more than 3,750 pounds are subject to a 1.7 grams per mile standard for these model years.

The first vehicle standards were implemented by the Federal government in 1968 and were concentration based (ppm of exhaust for hydrocarbons and CO). The first mass based standards (g/mile) were in 1972.

Table 3-12. Federal Test Procedure Exhaust Emissions Standards and Schedule for Light-Duty Vehicles and Light-Duty Trucks, 1992 to 1998

			Vehicle Useful Life (grams/mile)									
			5 Years/50,100 Miles					10 Years/100,100 Miles[1]				
Vehicle Type	**Emission Category**	**Year[2]**	**THC[3]**	**NMHC[4]**	**CO**	**NO_x**	**PM_{10}**	**THC**	**NMHC**	**CO**	**NO_x**	**PM_{10}**
LDV	Tier 0	1992	0.41	0.34	3.4	1.0	0.20					
LDV	Tier I	1996	0.41	0.25	3.4	0.4	0.08		0.31	4.2	0.6	0.10
LDGT1a[5]	Tier 0	1992						0.80	0.67	10	1.2	0.26
LDGT1a	Tier I	1996		0.25	3.4	0.4	0.08	0.80	0.31	4.2	0.6	0.10
LDGT1b[6]	Tier 0	1992						0.80	0.67	10	1.7	0.13
LDGT1b	Tier I	1996		0.32	4.4	0.7	0.08	0.80	0.40	5.5	0.97	0.10
LDGT2a[7]	Tier 0	1992						0.80	0.67	10	1.7	0.26
LDGT2a	Tier I	1997		0.32	4.4	0.7		0.80	0.46	6.4	1.0	0.10
LDGT2b[8]	Tier 0	1992						0.80	0.67	10	1.7	0.13
LDGT2b	Tier I	1997		0.39	5.0	1.1		0.80	0.56	7.3	1.53	0.12

Notes:
[1] LDGT2: 11 years/120,000 miles
[2] Year Standard is 100 percent of vehicles affected
[3] Total hydrocarbons
[4] Nonmethane Hydrocarbon
[5] Any light light-duty truck up through 3,750 lbs loaded vehicle weight.
[6] Any light light-duty truck greater than 3,750 lbs loaded vehicle weight.
[7] Any heavy light-duty truck up through 5,750 lbs adjusted loaded vehicle weight.
[8] Any heavy light-duty truck greater than 5,750 lbs adjusted loaded vehicle weight.

The first vehicle standards were implemented by the Federal government in 1968 and were concentration based (ppm of exhaust for hydrocarbons and CO). The first mass based standards (g/mile) were in 1972.

Source: U.S. EPA Office of Mobile Sources, EPA-420-B-98-001

Table 3-13. Total National Emissions by Pollutant and Year

Year	CO	NO_x	VOC	SO_2	PM_{10}	$PM_{2.5}$	Pb	NH_3
1940	93,616	7,374	17,161	19,952	15,957			
1941	91,657	8,262	17,235	22,857	16,074			
1942	92,449	8,389	16,358	24,541	16,192			
1943	93,241	8,972	16,323	26,846	16,309			
1944	94,033	9,455	16,539	27,092	16,427			
1945	94,825	9,548	17,308	26,007	16,545			
1946	95,617	9,993	20,549	23,297	16,663			
1947	96,409	10,470	19,507	26,298	16,780			
1948	97,202	9,985	19,349	24,284	16,898			
1949	97,993	10,247	19,720	20,801	17,016			
1950	102,609	10,093	20,936	22,357	17,133			
1951	99,285	10,535	20,398	21,477	16,976			
1952	99,784	11,056	20,208	20,826	16,818			
1953	100,283	11,104	21,258	20,920	16,661			
1954	100,782	11,663	21,232	20,181	16,503			
1955	101,281	11,563	21,973	20,883	16,345			
1956	101,780	11,867	22,902	21,039	16,188			
1957	102,279	12,248	22,784	21,272	16,031			
1958	102,778	13,012	21,846	22,634	15,873			
1959	103,278	13,486	22,703	22,654	15,715			
1960	109,745	14,140	24,459	22,227	15,558			
1961	106,207	13,809	24,584	22,142	15,286			
1962	108,637	14,408	25,036	22,955	15,014			
1963	111,067	15,100	27,062	24,133	14,742			
1964	113,498	15,871	26,948	25,301	14,470			
1965	115,928	16,579	27,630	26,750	14,198			
1966	118,358	17,390	27,827	28,849	13,926			
1967	120,788	17,635	28,209	28,493	13,654			
1968	123,219	18,372	26,568	30,263	13,382			
1969	125,649	18,847	26,764	30,961	13,110			
1970	129,444	20,928	30,982	31,161	13,042		220,869	
1971	129,491	21,559	30,039	29,686	11,335		243,415	
1972	128,779	22,740	30,297	30,390	10,734		255,555	
1973	125,935	23,529	29,873	31,754	10,237		223,686	
1974	119,978	22,915	28,042	30,032	9,636		178,693	
1975	116,757	22,632	26,079	28,011	7,671		159,659	
1976	120,963	24,051	26,991	28,435	7,906		165,349	
1977	120,868	24,808	27,426	28,623	7,739		152,467	
1978	122,150	25,070	27,655	26,877	7,865		137,964	
1979	118,475	24,716	27,161	26,941	7,571		116,786	
1980	117,434	24,384	26,336	25,905	7,119		74,153	
1981	114,396	24,211	24,956	24,612	6,605		58,884	
1982	112,260	23,785	23,866	23,319	5,274		57,666	
1983	117,675	23,639	25,078	22,807	6,021		49,232	
1984	116,533	24,322	26,015	23,816	6,281		42,217	
1985	117,013	23,198	24,428	23,658	45,445		22,890	
1986	111,688	22,808	23,617	22,892	51,137		7,296	
1987	110,798	23,068	23,470	22,675	42,533		6,840	
1988	118,729	24,124	24,306	23,135	61,072		7,053	
1989	106,439	23,893	22,513	23,293	53,064		5,468	

Table 3-13 (continued)

Year	CO	NO_x	VOC	SO_2	PM_{10}	$PM_{2.5}$	Pb	NH_3
1990	98,523	24,049	20,936	23,660	29,962	7,958	4,975	4,331
1991	100,872	24,249	21,102	23,041	29,560	7,739	4,169	4,390
1992	97,630	24,596	20,659	22,806	29,472	7,648	3,810	4,449
1993	98,160	24,961	20,868	22,466	28,006	7,327	3,916	4,521
1994	102,643	25,372	21,535	21,870	30,913	7,975	4,047	4,589
1995	93,353	24,921	20,817	19,181	27,070	7,179	3,929	4,665
1996	95,479	24,676	18,736	19,121	33,041	8,194	3,899	4,772
1997	94,410	24,824	18,876	19,622	34,226	8,483	3,952	4,837
1998	89,454	24,454	17,917	19,647	34,741	8,379	3,973	4,935

Figure 3-1. Trend in Gross Domestic Product, Population, Vehicle Miles Traveled, Total Fuel Consumption, combined VOLATILE ORGANIC COMPOUND and NITROGEN OXIDES Emissions, and SULFUR DIOXIDE Emissions, 1970 to 1998

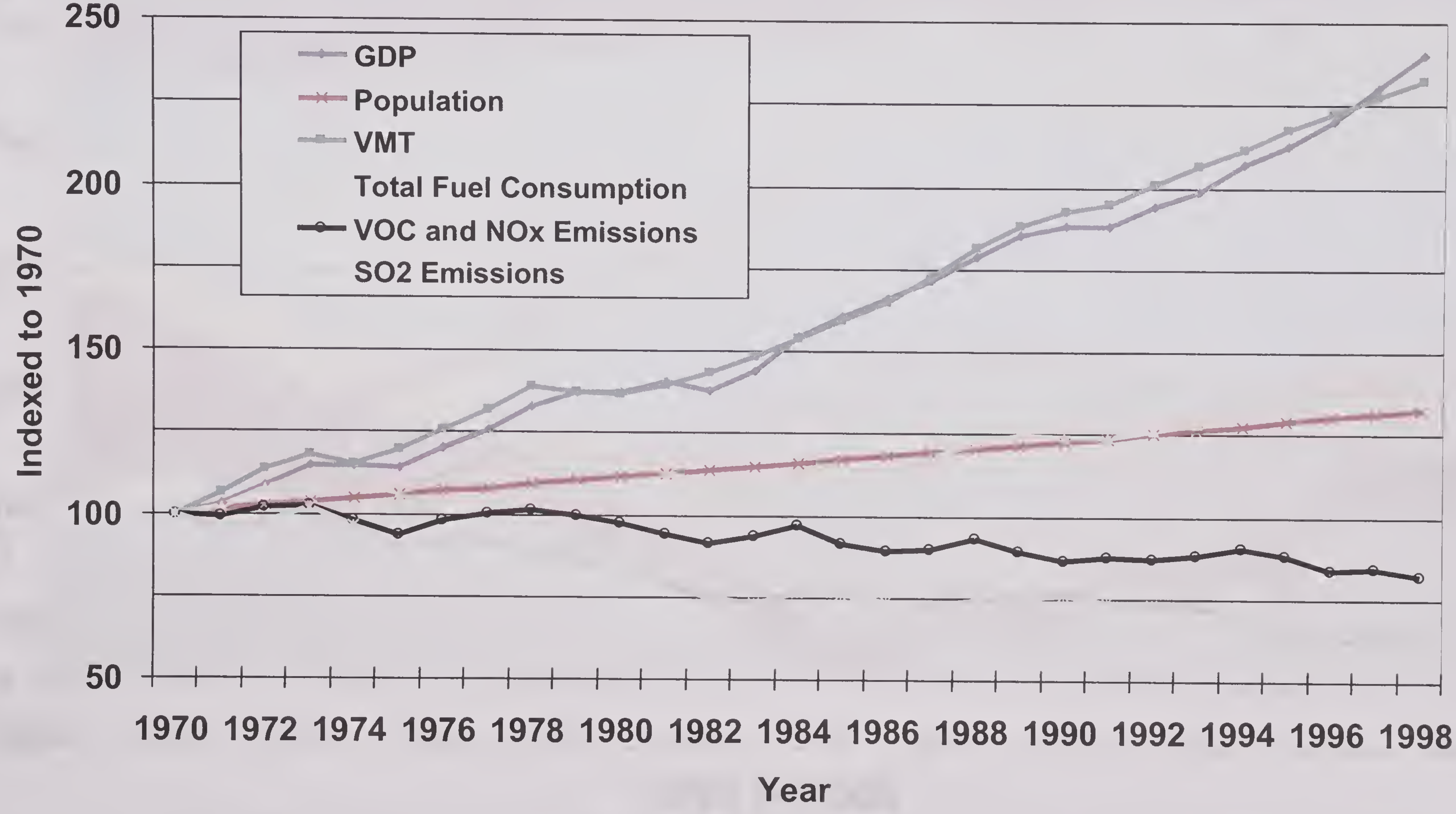
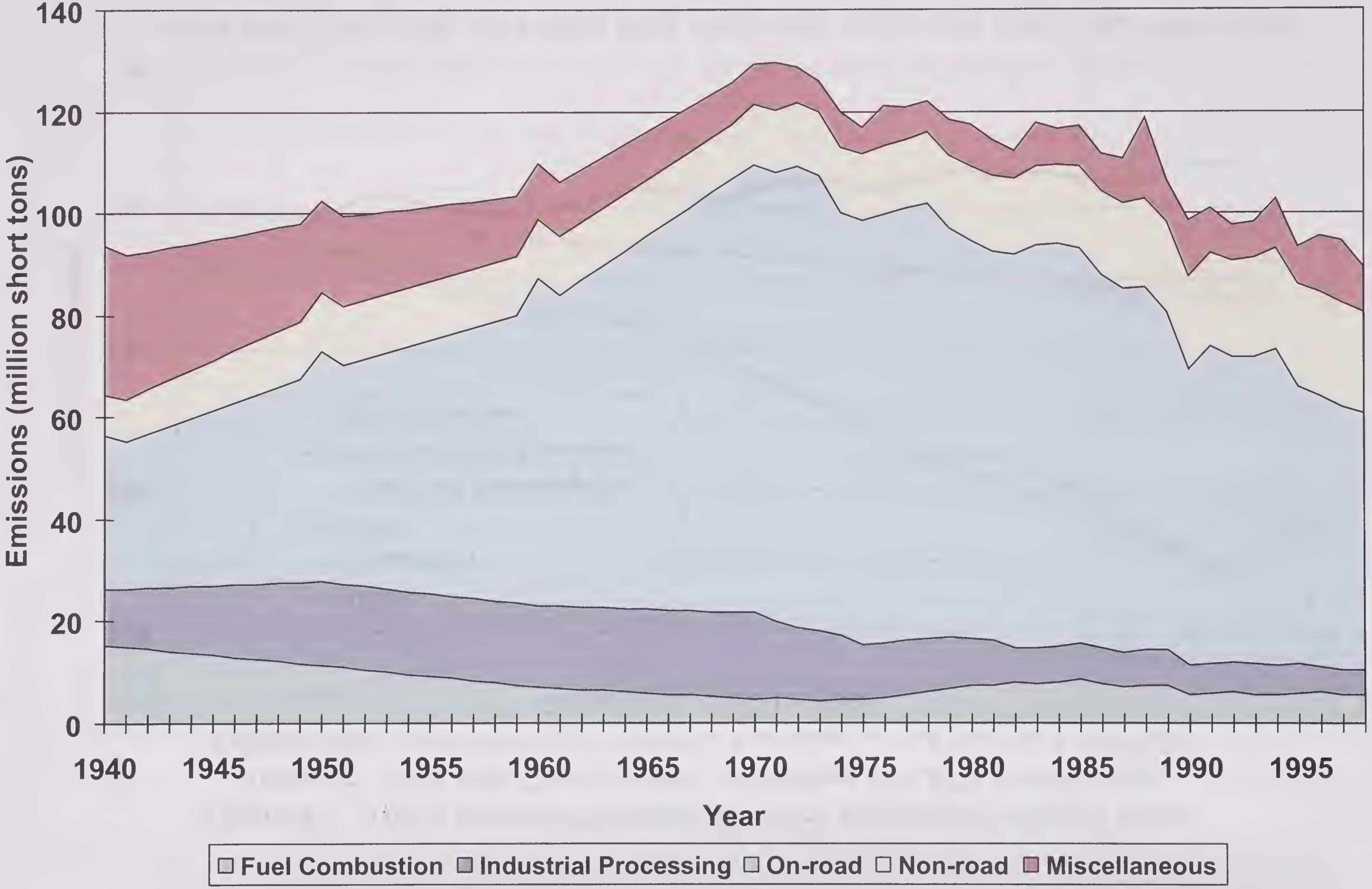
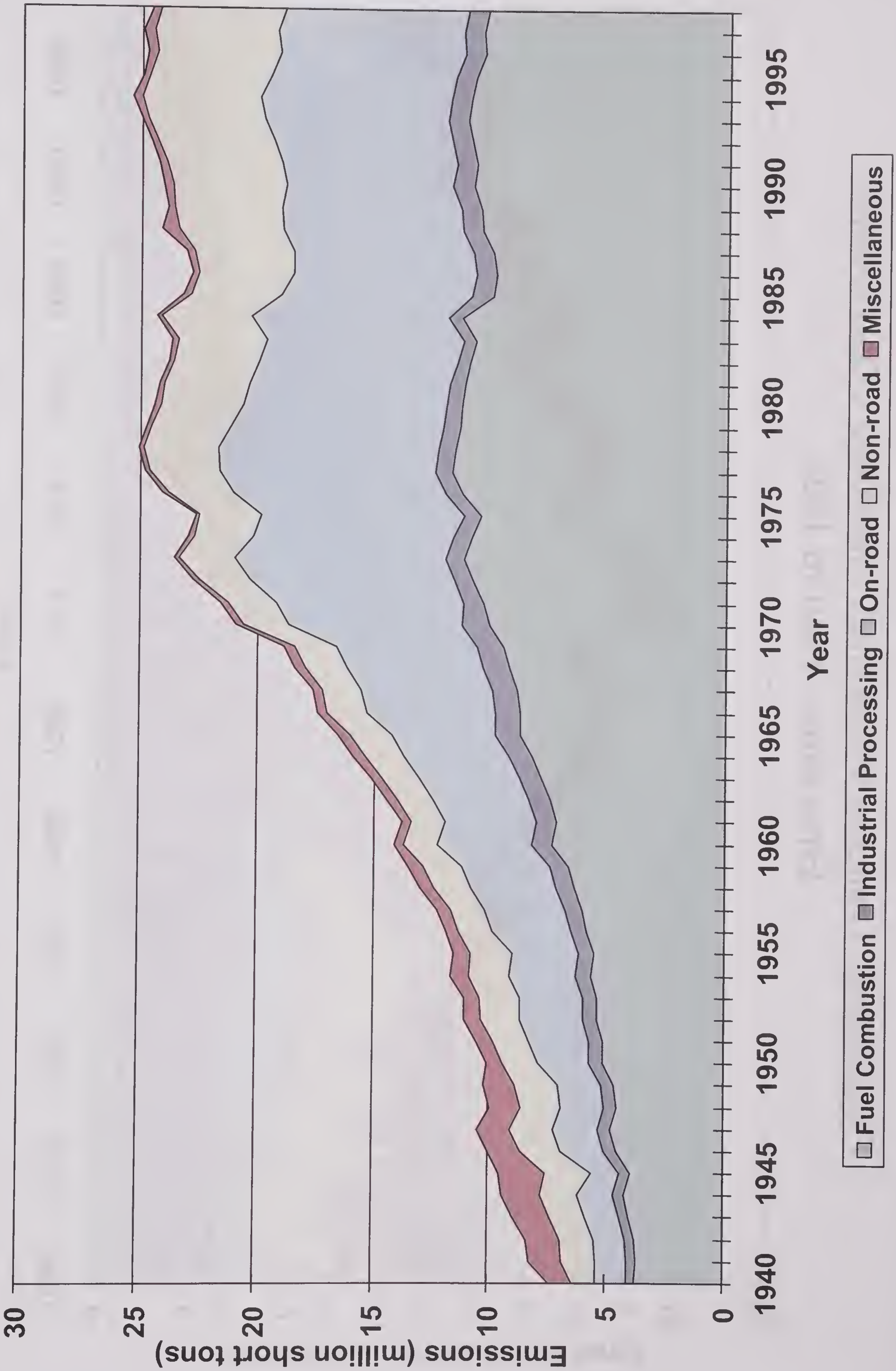


Figure 3-2. Trend in CARBON MONOXIDE Emissions, 1940 to 1998



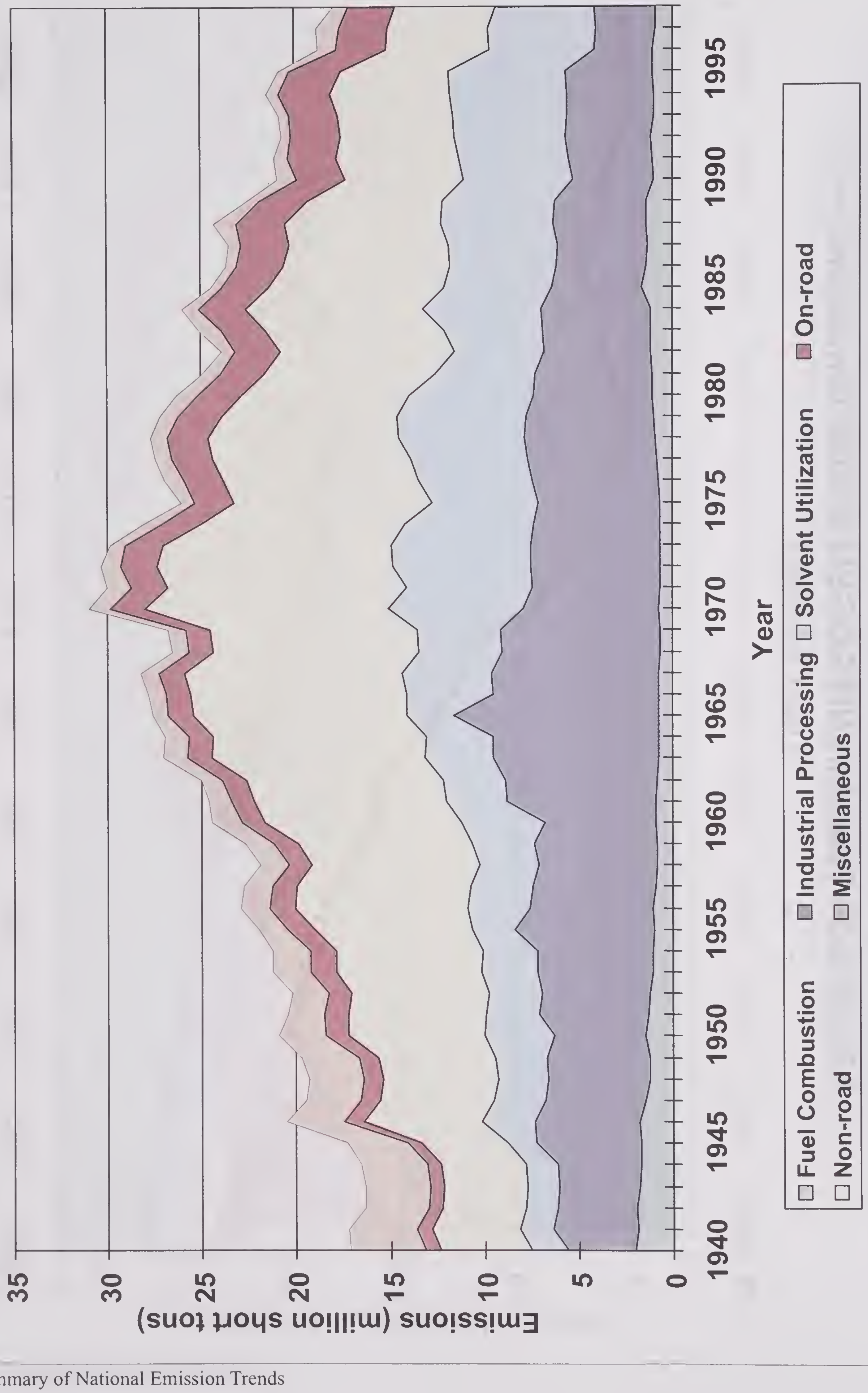
Note: Some fluctuations in the years before 1970 are the result of different methodologies

Figure 3-3. Trend in NITROGEN OXIDE Emissions, 1940 to 1998



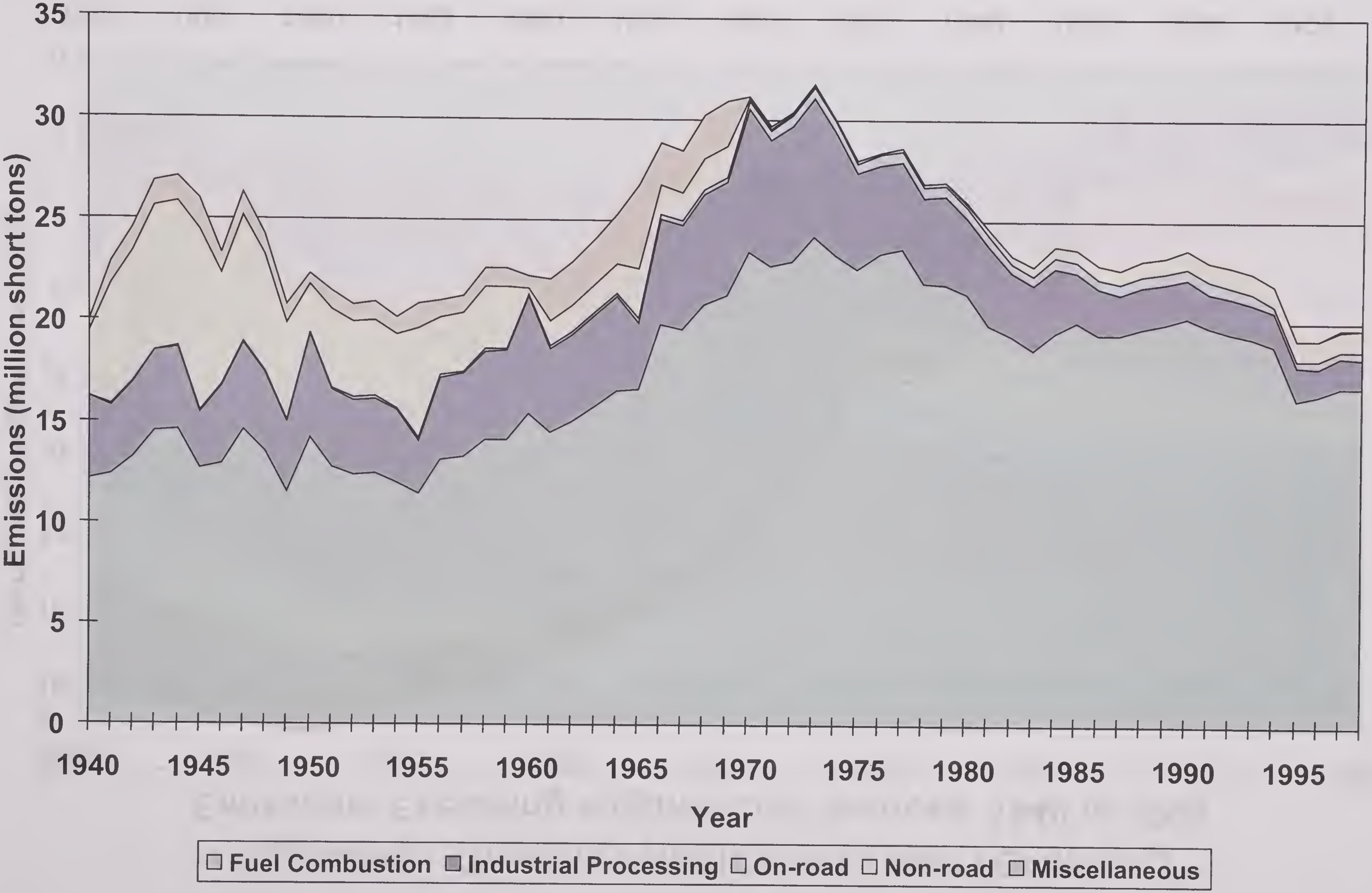
Note: Some fluctuations in the years before 1970 are the result of different methodologies

Figure 3-4. Trend in VOLATILE ORGANIC COMPOUND Emissions, 1940 to 1998



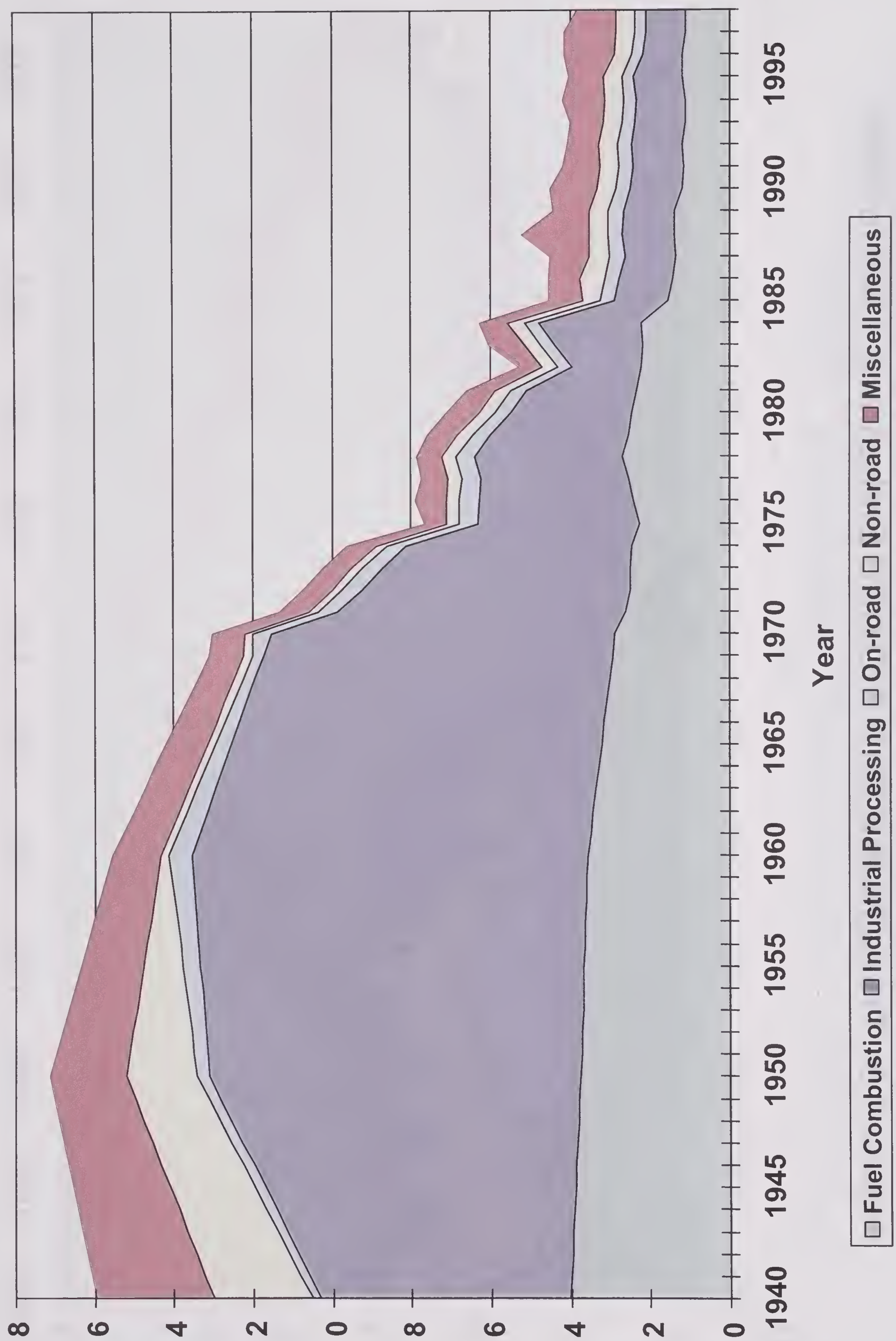
Note: some fluctuations in the years before 1970 are the result of different methodologies

Figure 3-5. Trend in SULFUR DIOXIDE Emissions, 1940 to 1998



Note: Some fluctuations in the years before 1970 are the result of different methodologies

Figure 3-6. Trend in PARTICULATE MATTER (PM $_{10}$) Emissions Excluding Fugitive Dust Sources, 1940 to 1998



Note: Some fluctuations in the years before 1970 are the result of different methodologies

Figure 3-7. Trend in Directly Emitted PARTICULATE MATTER ($PM_{2.5}$) Emissions Excluding Fugitive Dust Sources, 1990 to 1998

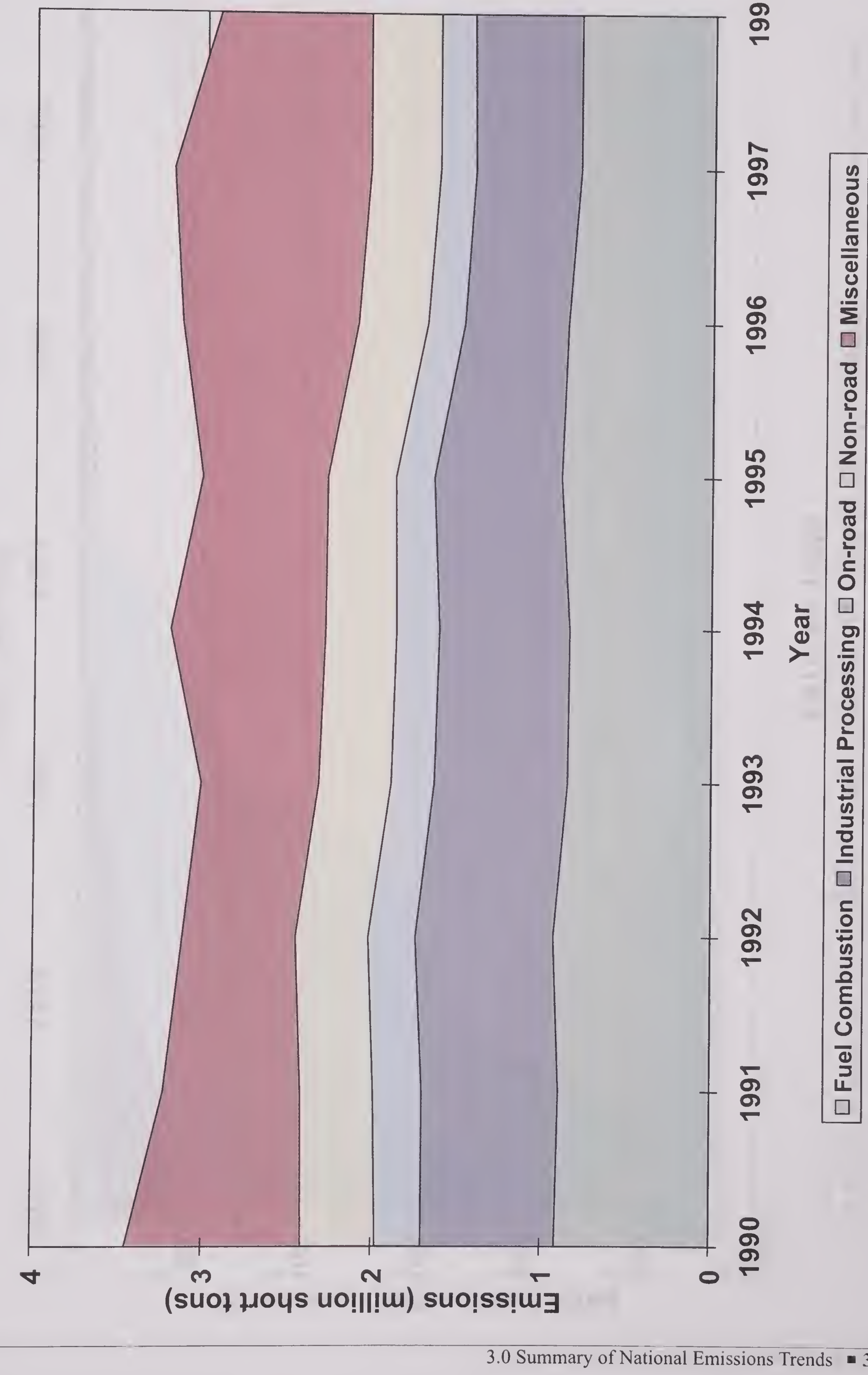
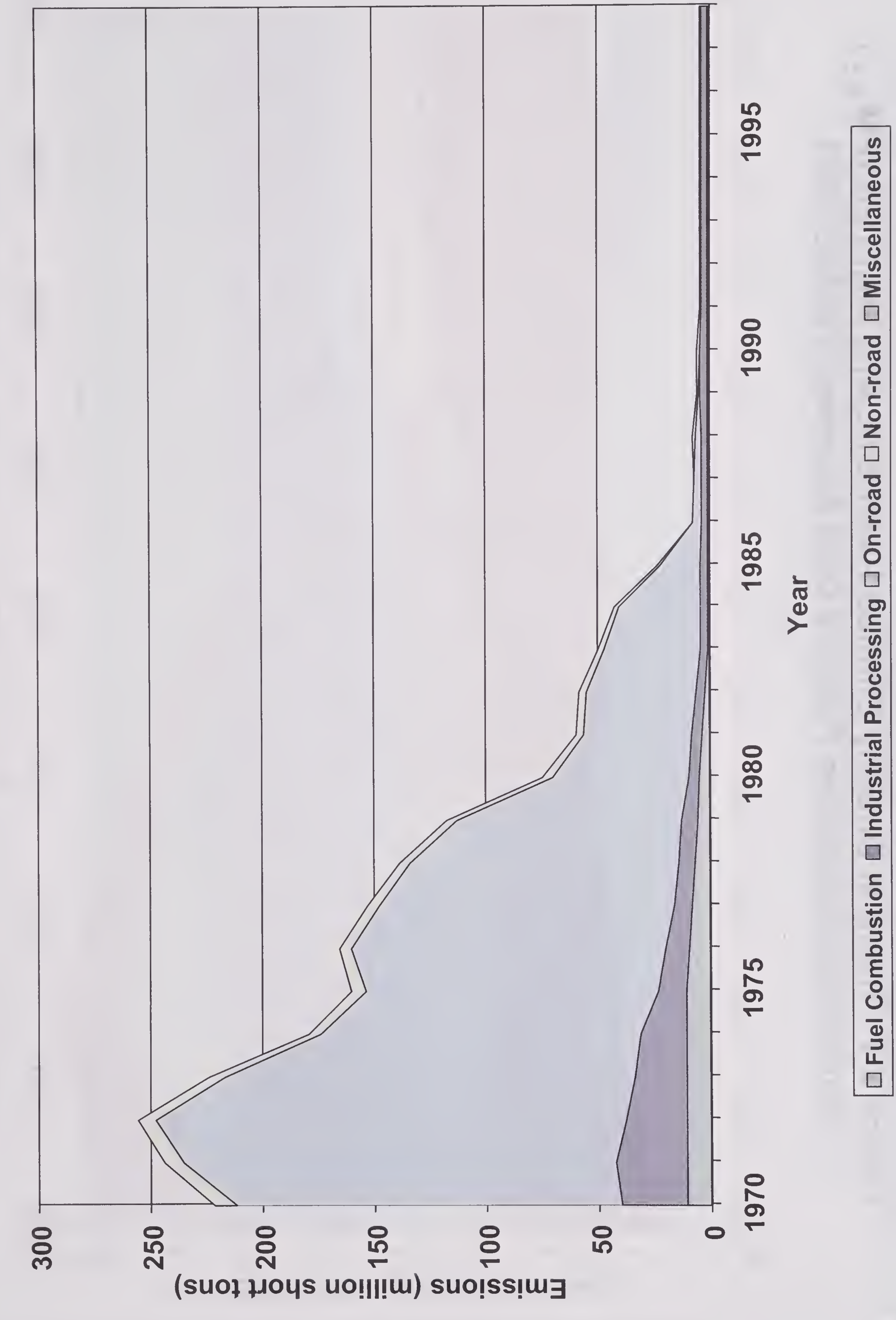


Figure 3-8. Trend in LEAD Emissions, 1970 to 1998



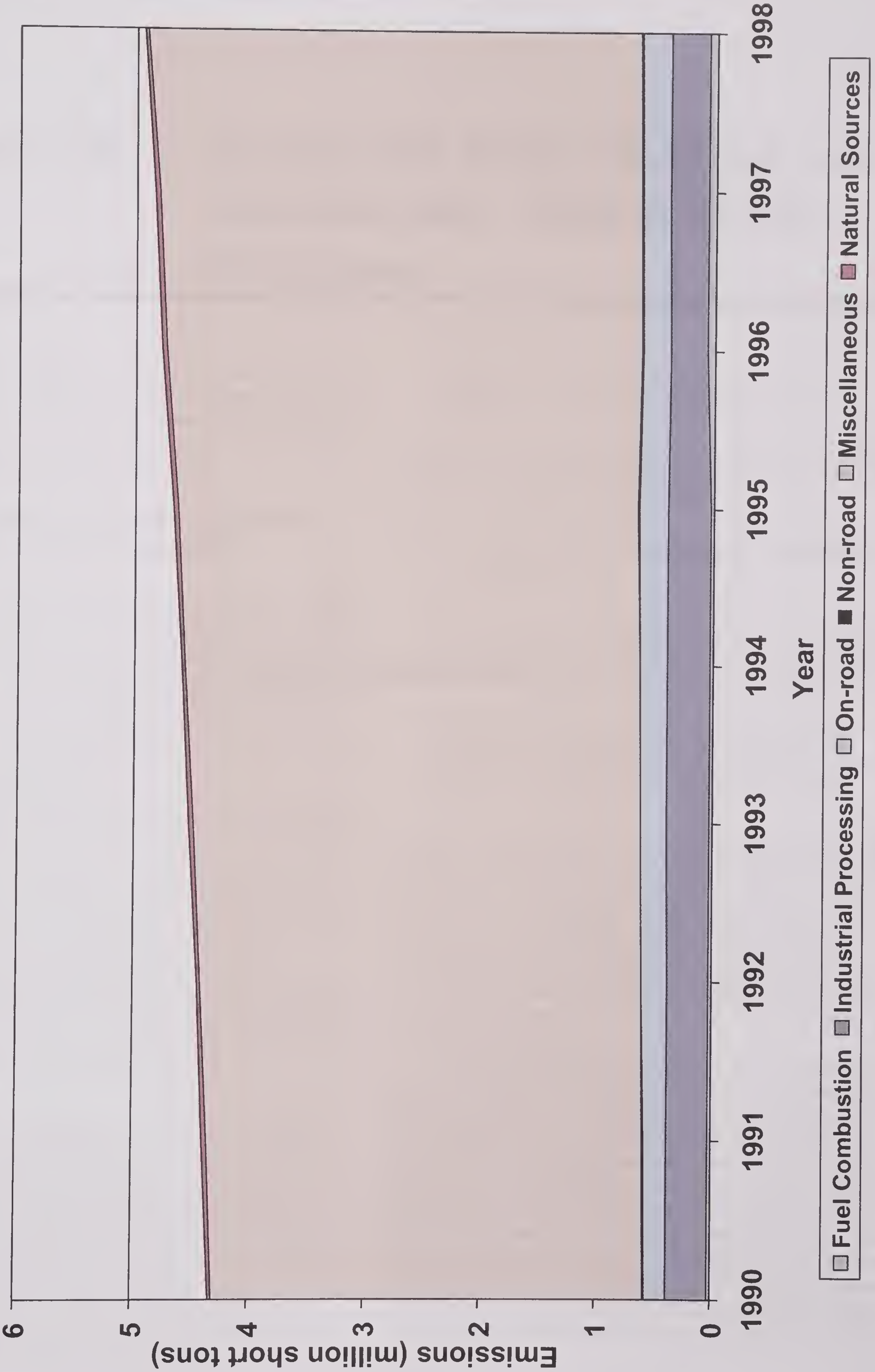


Figure 3-9. Trend in AMMONIA Emissions, 1990 to 1998

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Chapter 4.0 Section 406 of the Clean Air Act Amendments: Industrial SO_2 Emissions

This chapter discusses the impact of industrial sulfur dioxide (SO_2) emissions, the source categories comprising industrial emissions, base year emissions development, projected emissions methodology, long-term emission trends, and desulfurization of diesel fuel benefits.

4.1 WHY A SEPARATE CHAPTER FOR INDUSTRIAL SO_2 EMISSIONS?

The major health effects associated with high exposures to SO_2 in the ambient air include problems in breathing, respiratory illness, alterations in the lung's defenses, and aggravation of existing respiratory and cardiovascular disease. People most sensitive to SO_2 include asthmatics and individuals with chronic lung disease (such as bronchitis or emphysema) or cardiovascular disease. Children and the elderly may also be sensitive.

SO_2 also produces foliar damage on trees and agricultural crops. SO_2 and nitrogen oxides (NO_x) in the air cause acidic deposition, commonly known as acid rain. Acid rain is associated with a number of effects including acidification of lakes and streams, damage to high-elevation forests, and accelerated corrosion of buildings and monuments. SO_2 and NO_x emissions also form sulfates and nitrates in the atmosphere that can significantly impair visibility.

This chapter provides information required under section 406 of the Clean Air Act Amendments (CAAA) of 1990 (42 U.S.C. 7651 note), which deals with SO_2 emissions from industrial sources. Section 406(a) states that:

> *Not later than January 1, 1995 and every 5 years thereafter, the Administrator of the Environmental Protection Agency shall transmit to the Congress a report containing an inventory of national annual sulfur dioxide emissions from industrial sources (as defined in title IV of the Act), including units subject to section 405(g)(6) of the Clean Air Act, for all years for which data are available, as well as the likely trend in such emissions over the following 20-year period. The reports shall also contain estimates of the actual emission reduction in each year resulting from promulgation of the diesel fuel desulfurization regulations under section 214.*

As discussed below, the United States (U.S.) Environmental Protection Agency (EPA) intends this chapter to provide the information required in section 406(a).

4.1.1 What Source Categories Are Industrial Sources?

Several provisions of the CAA and the CAAA address what source categories are industrial sources. Section 402(24) of the CAA defines industrial sources. An industrial source is:

> a unit that does not serve a generator that produces electricity, a "nonutility unit" as defined in this section, or a process source as defined in section 410(e).

Further, section 406(a) of the CAAA of 1990 states that "industrial sources" include units subject to section 405(g)(6) of the CAA. (EPA believes that the reference in section 406(b) to section 405(g)(5) is erroneous and reads if as referring to section 405(g)(6).) Section 405(g)(6) of the CAA excludes from the Acid Rain Program under Title IV of the CAA certain "qualifying small power production facilit[ies]," "qualifying cogeneration facilit[ies]," and "independent power production facilit[ies]."

In order to determine the scope of the term "industrial source," it is necessary to consider several other statutory and regulatory definitions and provisions. Section 402(15) of the CAA defines "unit" as a "fossil fuel-fired combustion device." Section 72.2 of the regulations implementing Title IV of the CAA defines "fossil-fuel fired" as combusting "fossil fuel or any derivative of fossil fuel alone or in combination with any other fuel, independent of the percentage of fossil fuel consumed in any calendar year." Section 402(17)(A) of the CAA provides that a "utility unit" is, with certain exceptions (e.g., for certain cogeneration units under section 402(17)(C)), any unit that "serves a generator in any State that produces electricity for sale" or that, "during 1985, served a generator in any State that produced electricity for sale."

The categories of "industrial sources" referred to in section 406(a) of the CAAA of 1990 must be considered in light of these definitions and provisions. With regard to the category of "nonutility units," section 402(25) of the CAA defines a "nonutility unit" as "a unit other than a utility unit." This category comprises all stationary combustion devices that burn any fossil fuel and that are not affected units under the Acid Rain Program in Title IV of the CAA. Because the definition of this category excludes units that are utility units and, except for nonutility units that opt into the Acid Rain Program under section 410 of the CAA, only utility units are affected units, the category does not generally include any affected units.

For similar reasons, the next category of industrial sources, i.e., "units that do not serve a generator that produces electricity," excludes all utility units and thus generally excludes all affected units under the Acid Rain Program in Title IV of the CAA. However, there are some units that are not affected units under the Acid Rain Program (e.g., units in Alaska and Hawaii and certain cogeneration units under section 402(17)(C)) but that do serve a generator that produces electricity. Therefore, this category of industrial sources is smaller than the "nonutility unit" category and excludes some stationary fossil-fuel fired combustion devices that are not affected units.

Another category of industrial sources (i.e., "process sources") is not defined in Title IV of the CAA. Section 410(d) refers to "process sources" but does not define the term. For the purposes of this chapter, a process source is any source that emits SO_2 as the result of a production or manufacturing process and not as the result of any type of fuel combustion.

The last category of industrial sources comprises units that are utility units but that are exempt from the Acid Rain Program under section 405(g)(6) of the CAA. This includes certain "qualifying small power production facilities" or "qualifying cogeneration facilities" under section 3(17)(C) or 3(18)(B) of the Federal Power Act and certain "independent power production facilities" under section 416(a)(2)(A), (B), and (D) of the CAA. These terms are defined in section 72.2 of the regulations implementing the Acid Rain Program.

Finally, for purposes of applying the 5.60 million ton annual cap for SO_2 emissions from industrial sources, which is specified in section 406(b) of the CAAA of 1990, commercial/institutional/residential sources are excluded. This is because the 5.60 million ton cap was developed using emissions in the 1985 National Acid Precipitation Assessment Program NAPAP[1] inventory that cover sources involving industrial combustion and industrial/manufacturing processes and do not cover commercial/institutional/residential sources. Commercial/institutional/residential sources encompass combustion sources, such as those located at hospitals, universities, or residences, that are not related to the production of physical products.

In summary, industrial sources covered by the 5.60 million ton annual cap include: all stationary fossil-fuel fired combustion devices, except for affected utility units under the Acid Rain Program and except for commercial/institutional/residential sources; and all process sources.

Table 4.1 presents the source categories defined as industrial sources.

4.2 WHY USE 1996 AS THE BASE YEAR?

Section 406 of the CAAA of 1990 specifies a 5.60 million ton cap on SO_2 emissions from industrial sources. Congress derived the cap from industrial source emission estimates developed as part of the 1985 NAPAP inventory. The 1990 National Emission Trends inventory (now called the "NET inventory"), developed from the 1985 NAPAP inventory, served as the baseline for the previous industrial SO_2 emission projections presented in the report "National Annual Industrial Sulfur Dioxide Emission Trends, 1995-2015: Report to Congress."[2] Since that report, EPA, along with State and local agencies, revised the emission inventory for two separate time periods for different purposes. The most recent effort by EPA was the incorporation of 1996 Periodic Emission Inventories (PEI) into the NET inventory. (Refer to Section 5.6 for discussions on the PEI).

Since the 1996 NET inventory contains the most recent comprehensive emissions inventory, EPA chose it for the baseline for the industrial SO_2 emission estimates in this chapter. Table 4.2 presents the source of base year data for each of the 48 contiguous States. Thirty states provided 1996 point source emission inventories to the EPA, and 12 states provided acceptable 1996 area source emission inventories. The emissions for Oregon are from the Grand Canyon Visibility Transport Commission (GCVTC) 1990 inventory. The point source emissions for 7 other States and the area source emissions for 16 other States are estimated from the Ozone Transport Assessment Group (OTAG) 1990 inventory. The emission estimates for Alaska and Hawaii point sources are from multi-year Aerometric Information Retrieval System/AIRS Facility Subsystem (AIRS/AFS) retrievals, and EPA has never sent these estimates to these States for review. EPA estimated the area source emissions for Alaska and Hawaii. The remaining emissions are from the 1985 NAPAP inventory.

For States that did not provide EPA with a 1996 complete inventory, EPA estimated their emissions for 1996 using Bureau of Economic Analysis (BEA) growth factors. EPA did not assume any new controls nor plant retirements for these sources. More details on the methodology to estimate 1985 to 1996 emissions can be found in the NET inventory procedures document.[3]

Figure 4.1 presents the SO_2 industrial source emissions by major source categories for the year 1996. Fuel combustion sources are the largest contributors to industrial SO_2 emissions.

4.3 HOW DID EPA PROJECT EMISSIONS?

In addition to a national inventory of SO_2 emissions, section 406 of the CAAA of 1990 also calls for presentation of the likely trend in such emissions over the following 20-year period. Thus, Congress requires EPA to estimate future industrial source SO_2 emissions under section 406. Although section 406 calls for development of the likely trend in emission for a 20-year period, EPA developed emission estimates from 1996 (the base year) to 2020 since 2020 represents 20 years from the completion date of this report.

EPA considered fuel switching, energy efficiency (the amount of energy saved from the use of more efficient processes through time), and economic growth in the development of these projections. In general, less fuel will be needed to provide the same amount of energy (in the form of steam) to an industrial process and the amount of energy needed per unit output will also decrease as processes become more efficient. Fuel switching and energy efficiency are reflected in energy correction factors based on information obtained from the U.S. Department of Energy (DOE) publication Annual Energy Outlook 1997. Economic growth factors were derived from the 1995 BEA Gross State Product (GSP) projections by 2-digit Standard Industrial Classification (SIC) code. These were applied to estimate changes in activity between 1996 and 2030.[4] For the purposes of satisfying section 406 requirements, a value was needed on 3-year intervals through 2020. Therefore, projections were calculated by applying growth ratios among existing sources to their base year emissions (1996). Interpolated factors were then applied to these same categories to estimate the every 3-year trend.

Further analysis of the 20-year projection is currently underway at EPA and results will be reported in the next Trends Report (planned for January 2001 publication).

4.4 WHAT IS THE TREND IN INDUSTRIAL SO_2 EMISSIONS?

Figure 4.2 presents the estimated trends in industrial source SO_2 emissions from 1900 to 2020. Table 4.3 presents the emissions by source category for every 3 years starting with 1996. The year 2007 is also displayed. The subcategories for solvent utilization and storage and transport are not displayed since these emissions are very small.

The emission estimates for the base year 1996 are 4.4 million short tons. The emission estimates show the industrial SO_2 emissions increasing steadily with the 20-year rate at approximately 8 percent. Fuel combustion sources continue to be the largest contributor to industrial SO_2 emissions. The emission estimates show the fuel combustion emissions declining through the years, primarily from the result of energy efficiency factors. The largest increase in SO_2 can be seen in chemical and allied manufacturing, which is projected to rise 30 percent in the 20-year period. Total industrial source SO_2 emissions are currently projected to be approximately 4.7 million tons in 2020. Refer to Figure 4-3 for a graphical presentation of each category's 2020 contribution.

4.4.1 Will the Cap Be Exceeded?

Section 406(b) of the CAAA of 1990 states:

> *Whenever the inventory required by this section indicates that sulfur dioxide emissions from industrial sources, including units subject to section 405(g)(6) of the [CAA], may reasonably be expected to reach levels greater than 5.60 million tons per year, the Administrator of the [EPA] shall take such actions under the [CAA] as may be appropriate to ensure that such emissions do not exceed 5.60 million tons per year. Such actions may include the promulgation of new and revised standards of performance for new sources, including units subject to section 405(g)(6) of the [CAA], under section 111(b) of the [CAA], as well as promulgation of standards of performance for existing sources, including units subject to section 405(g)(5) of the [CAA], under authority of this section.*

(As noted above, the reference to section 405(g)(5) should be to section 405(g)(6).)

The current emission estimates indicate that emissions of SO_2 from industrial sources will not exceed the 5.6 million tons per year cap through the year 2020. As stated earlier, more refinement of these estimates is ongoing and a revised projection will be released with the publication of the next Trends report.

4.5 WHAT ARE THE BENEFITS FROM DESULFURIZATION OF DIESEL FUELS?

Section 406(a) of the CAAA of 1990 also requires that EPA provide to Congress a report that contains estimates of the actual emission reduction in each year resulting from promulgation of the diesel fuel desulfurization regulations under section 214. As a result of the regulation, industry reduced the sulfur content of diesel fuel 0.25 to 0.05 percent as of October 1, 1993. Figure 4.4 displays the emissions for on-road sources with and without desulfurization. As shown, emission reductions in the year 1993 are smaller than the other years since industry lowered the sulfur content of the fuel in October of that year. For the years 1994 through 1998, Figure 4.4 shows a 51 percent decrease in total vehicle emissions and a 400 percent decrease in diesel vehicle emissions, relative to what emissions would be without the fuel desulfurization program.

4.5.1 Why Are Current 1993 Emissions Without Desulfurization Higher Than the Values Presented in the 1995 Report to Congress?

The 1993 emissions for on-road vehicles without desulfurization differs from similar values presented in the "National Annual Industrial Sulfur Dioxide Emission Trends, 1995-2015: Report to Congress." EPA generated the values in the previous report prior to the release of its PART5 emissions model, which EPA currently uses to generate SO_2 emissions from on-road sources.

For all estimates prior to October 1, 1993, the previous calculation assumed a sulfur content of 0.20 instead of 0.25 percent, since the 0.20 value was the default value listed in EPA's AP-42 Emission Factor document.[5] When PART5 was released, the default value was changed to 0.25. However, past October 1, 1993, the default value was changed to 0.05, since 0.05 is the regulatory value:

Sulfur Content	*Year reflected in data*
0.20 (1995 Report)	Pre October 1, 1993
0.25 (This Report)	Pre October 1, 1993
0.05 (This Report)	All years after October 1, 1993

4.6 REFERENCES

1. "The 1985 NAPAP Emissions Inventory (Version 2): Development of the Annual Data and Modelers' Tapes." EPA-600/7-89-012a, Air and Energy Engineering Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.
2. "National Annual Industrial Sulfur Dioxide Emission Trends, 1995-2015: Report to Congress." EPA-454/R-95-001. Office of Air and Radiation, U.S. Environmental Protection Agency, Research Triangle Park, NC. June 1995.
3. "National Air Pollutant Emission Trends Procedures Document, 1900-1996." EPA-454/R-98-008. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1998.
4. "Procedures for Developing Base Year and Future Year Mass and Modeling Inventories for the Tier 2 Final Rulemaking," EPA-420-R-99-034, September, 1999 (found on the web at: http://www.epa.gov/otaq/tr2home.htm#tsd).
5. "Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources," 4th Edition, Supplement D through 5th Edition, Supplement B, AP-42. U.S. Environmental Protection Agency, Research Triangle Park, NC. 1997.

Table 4-1. Industrial SO_2 Tier Source Categories

Description Tier1	Tier2	Tier3
FUEL COMB. INDUSTRIAL		
	Coal	
		bituminous
		subbituminous
		anthracite and lignite
		other
	Oil	
		residual
		distillate
		other
	Gas	
	Other	
	Internal Combustion	
CHEMICAL & ALLIED PRODUCT MFG		
	Organic Chemical Mfg	
	Inorganic Chemical Mfg	
		sulfur compounds
		other
	Polymer & Resin Mfg	
	Agricultural Chemical Mfg	
	Paint, Varnish, Lacquer, Enamel Mfg	
	Pharmaceutical Mfg	
	Other Chemical Mfg	
METALS PROCESSING		
	Non-Ferrous Metals Processing	
		copper
		lead
		aluminum
		other
	Ferrous Metals Processing	
	Metals Processing NEC	
PETROLEUM & RELATED INDUSTRIES		
	Oil & Gas Production	
		natural gas
		other
	Petroleum Refineries & Related Industries	
		fluid catalytic cracking units
		other
	Asphalt Manufacturing	
OTHER INDUSTRIAL PROCESSES		
	Agriculture, Food, & Kindred Products	
	Textiles, Leather, & Apparel Products	
	Wood, Pulp & Paper, & Publishing Products	
	Rubber & Miscellaneous Plastic Products	
	Mineral Products	
		cement mfg
		other
	Machinery Products	
	Electronic Equipment	
	Transportation Equipment	
	Construction	
	Miscellaneous Industrial Processes	
SOLVENT UTILIZATION		
	Degreasing	
	Graphic Arts	
	Dry Cleaning	
	Surface Coating	
	Other Industrial	
	Nonindustrial	
	Solvent Utilization NEC	
STORAGE & TRANSPORT		
	Bulk Terminals & Plants	
	Petroleum & Petroleum Product Storage	
	Petroleum & Petroleum Product Transport	
	Service Stations: Stage I	
	Service Stations: Stage II	
	Service Stations: Breathing & Emptying	
	Organic Chemical Storage	
	Organic Chemical Transport	
	Inorganic Chemical Storage	
	Inorganic Chemical Transport	
	Bulk Materials Storage	
	Bulk Materials Transport	
WASTE DISPOSAL & RECYCLING		
	Incineration	
		industrial
	Open Burning	
		industrial
	Industrial Waste Water	
	TSDF	
		industrial
	Landfills	
		industrial

Table 4-2. Industrial SO_2 Point and Area Data Source Submittals

State	1996 PEI Point	1996 PEI Area	1990 OTAG Point	1990 OTAG Area	1985 NAPAP Point	1985 NAPAP Area	State	1996 PEI Point	1996 PEI Area	1990 OTAG Point	1990 OTAG Area	1985 NAPAP Point	1985 NAPAP Area
Alabama [1]	X	X					Nebraska	X					X
Arizona					X	X	Nevada					X	X
Arkansas [2]			X			X	New Hampshire	X			X		
California	X	X					New Jersey			X	X		
Colorado	X					X	New Mexico					X	X
Connecticut	X	X					New York			X	X		
Delaware	X	X					North Carolina	X			X		
Florida	X			X			North Dakota	X					X
Georgia [1]	X	X					Ohio			X	X		
Idaho [2]					X	X	Oklahoma	X	X				
Illinois	X			X			Oregon [3]						
Indiana	X	X					Pennsylvania [1,2]	X			X		
Iowa					X	X	Rhode Island			X	X		
Kansas	X					X	South Carolina	X					X
Kentucky	X			X			South Dakota	X					X
Louisiana	X	X					Tennessee			X	X		
Maine	X			X			Texas	X	X				
Maryland	X	X					Utah [2]					X	X
Massachusetts	X					X	Vermont	X			X		
Michigan	X			X			Virginia	X	X				
Minnesota			X			X	Washington	X	X				
Mississippi					X	X	West Virginia	X			X		
Missouri [1]	X	X					Wisconsin	X			X		
Montana	X					X	Wyoming					X	X

NOTE(S): 1: Only Partial State. See Tables 5.2 and 5.3 for more details.
2: PEI data submitted but not incorporated into NET inventory due to programming or timing difficulties. Data to be incorporated in FY 2000.
3: Data obtained from 1990 Grand Canyon Transport Visibility Commission

Table 4-3. Industrial SO_2 Projected Emissions by Selected Source Categories (thousand short tons)

Source Category	1996	1999	2002	2005	2007	2008	2011	2014	2017	2020
FUEL COMB. INDUSTRIAL	**3,022**	**3,023**	**3,024**	**3,024**	**3,025**	**3,022**	**3,012**	**3,002**	**2,993**	**2,983**
Coal	1,465	1,476	1,487	1,498	1,506	1,504	1,499	1,494	1,489	1,484
Oil	844	832	819	807	799	796	788	780	771	763
Gas	556	555	555	554	554	555	558	562	565	568
Other	140	142	145	147	149	149	149	149	149	149
Internal Combustion	17	17	17	18	18	18	18	18	18	18
CHEMICAL & ALLIED PRODUCT MFG	**291**	**301**	**312**	**322**	**329**	**333**	**344**	**356**	**368**	**379**
Organic Chemical Mfg	4	4	5	5	5	5	5	6	6	6
Inorganic Chemical Mfg	204	212	220	227	233	236	245	254	263	272
Polymer & Resin Mfg	1	1	1	1	1	1	1	1	1	1
Agricultural Chemical Mfg	1	1	1	1	1	1	1	1	1	1
Paint, Varnish, Lacquer, Enamel Mfg	0	0	0	0	0	0	0	0	0	0
Pharmaceutical Mfg	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	81	83	85	87	89	90	92	94	97	99
METALS PROCESSING	**428**	**438**	**447**	**457**	**463**	**467**	**478**	**490**	**501**	**513**
Non-Ferrous Metals Processing	283	295	306	318	325	329	340	351	362	374
Ferrous Metals Processing	128	125	122	120	118	118	117	117	116	116
Metals Processing NEC	17	18	19	19	20	20	21	22	23	23
PETROLEUM & RELATED INDUSTRIES	**337**	**340**	**343**	**346**	**348**	**351**	**358**	**365**	**372**	**380**
Oil & Gas Production	95	91	87	84	81	80	78	76	73	71
Petroleum Refineries & Related Industries	234	241	247	254	258	261	270	279	289	298
Asphalt Manufacturing	8	8	9	9	9	9	10	10	11	11
OTHER INDUSTRIAL PROCESSES	**349**	**354**	**359**	**364**	**368**	**370**	**376**	**383**	**389**	**395**
Agriculture, Food, & Kindred Products	4	4	4	5	5	5	5	5	5	5
Textiles, Leather, & Apparel Products	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	102	104	107	109	111	111	113	115	118	120
Rubber & Miscellaneous Plastic Products	0	0	0	0	0	0	0	0	0	0
Mineral Products	230	232	234	235	236	238	241	244	248	251
Machinery Products	0	0	0	0	0	0	0	0	0	0
Electronic Equipment	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	13	14	15	16	16	16	17	18	19	19
SOLVENT UTILIZATION	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
STORAGE & TRANSPORT	**3**	**3**	**3**	**3**	**3**	**3**	**4**	**4**	**4**	**4**
WASTE DISPOSAL & RECYCLING	**6**	**6**	**7**	**7**	**7**	**7**	**8**	**8**	**9**	**9**
Incineration	6	6	7	7	7	7	8	8	9	9
Open Burning	0	0	0	0	0	0	0	0	0	0
Industrial Waste Water	0	0	0	0	0	0	0	0	0	0
TSDF	0	0	0	0	0	0	0	0	0	0
Landfills	0	0	0	0	0	0	0	0	0	0
All Industrial SO_2 Emissions	4,437	4,466	4,496	4,526	4,545	4,554	4,582	4,609	4,638	4,665

Figure 4-1. SO_2 Emissions by Major Industrial Source Category, 1996

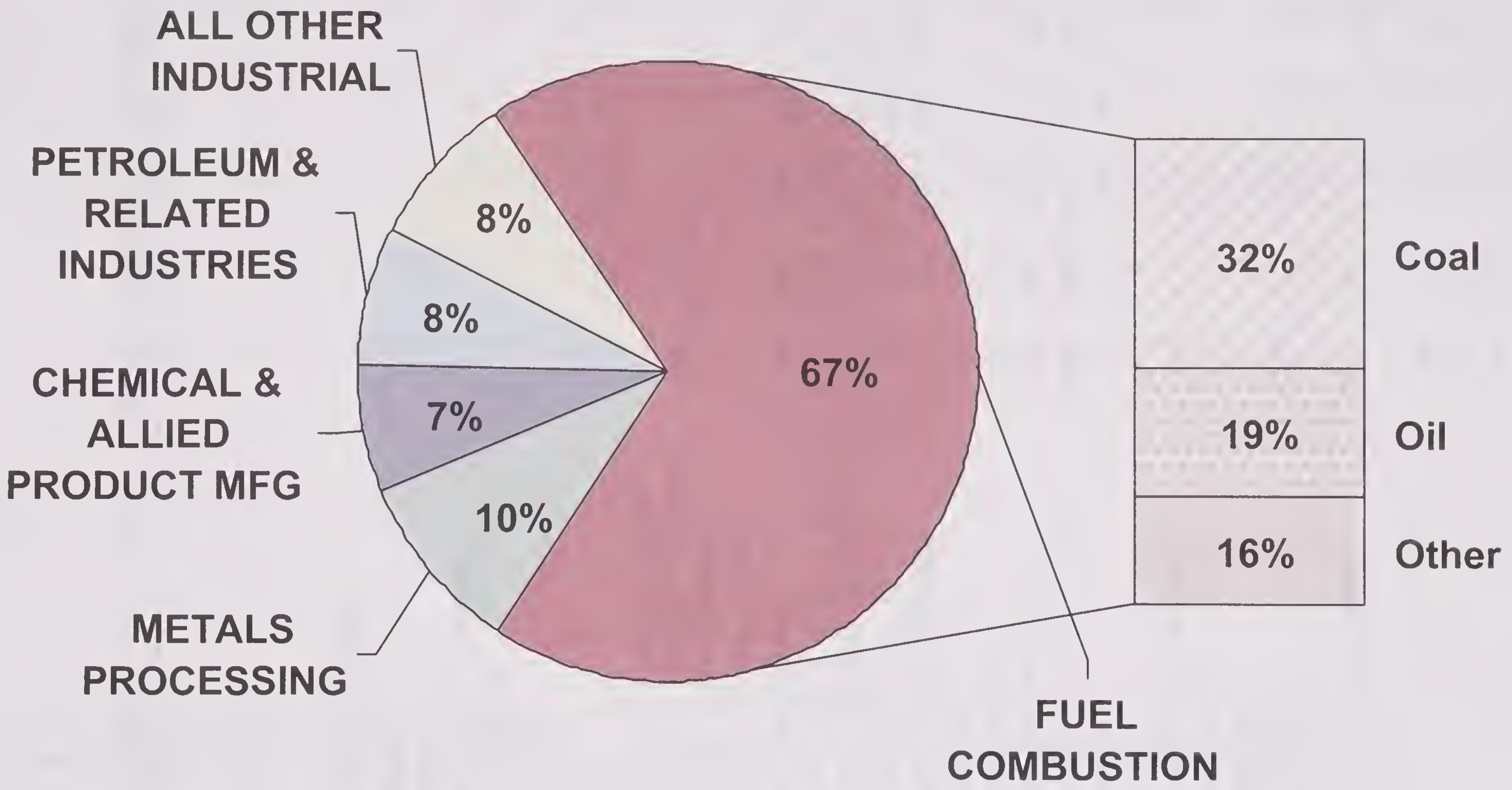
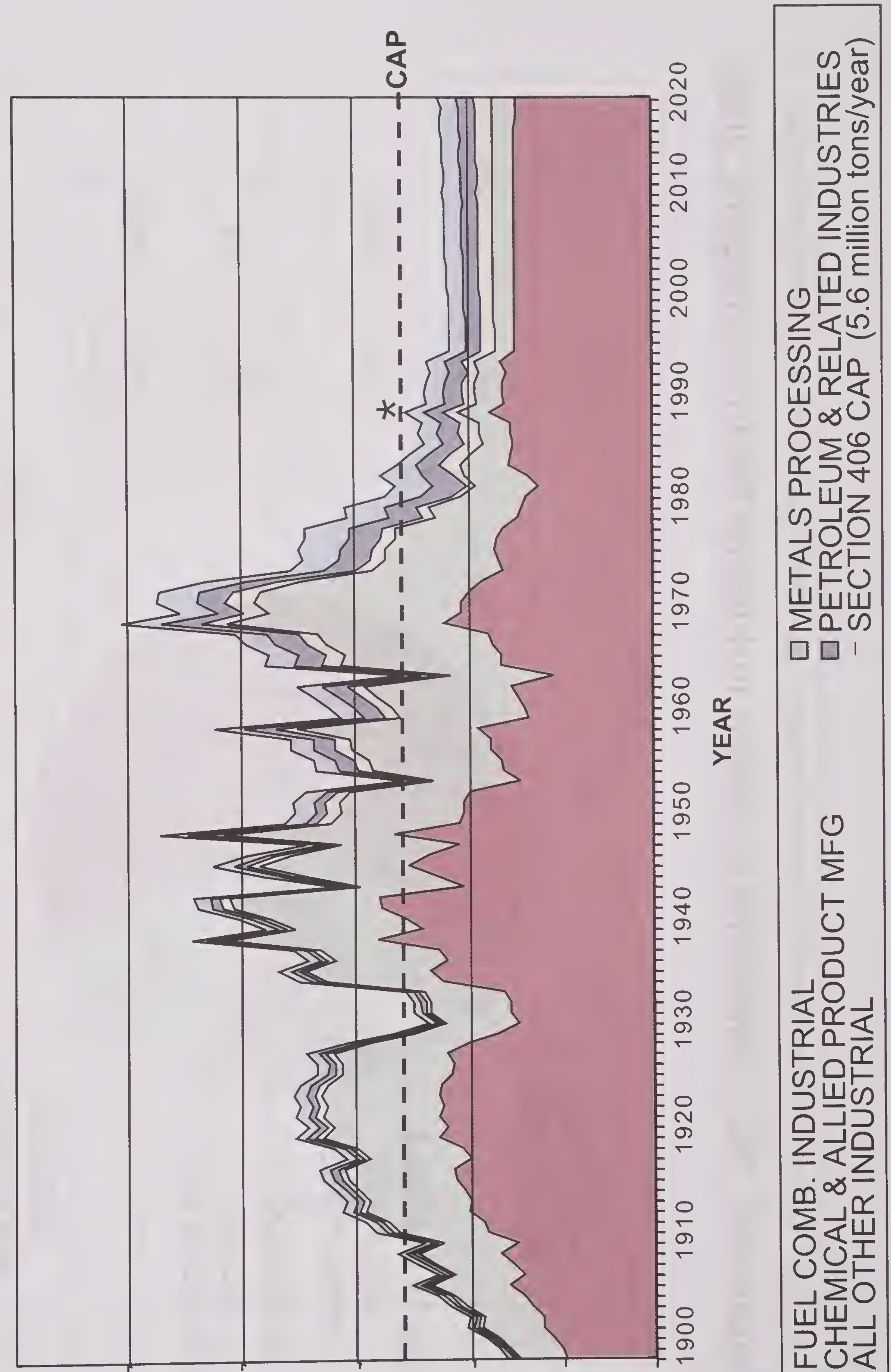


Figure 4-2. Industrial SO_2 Emissions (1900 to 2020)



* Note: Apparent spike in 1990 emissions is due to a methodology shift and should not be interpreted as a 1-year increase in industrial emissions.

Figure 4-3. SO_2 Emissions by Major Industrial Source Category, 2020

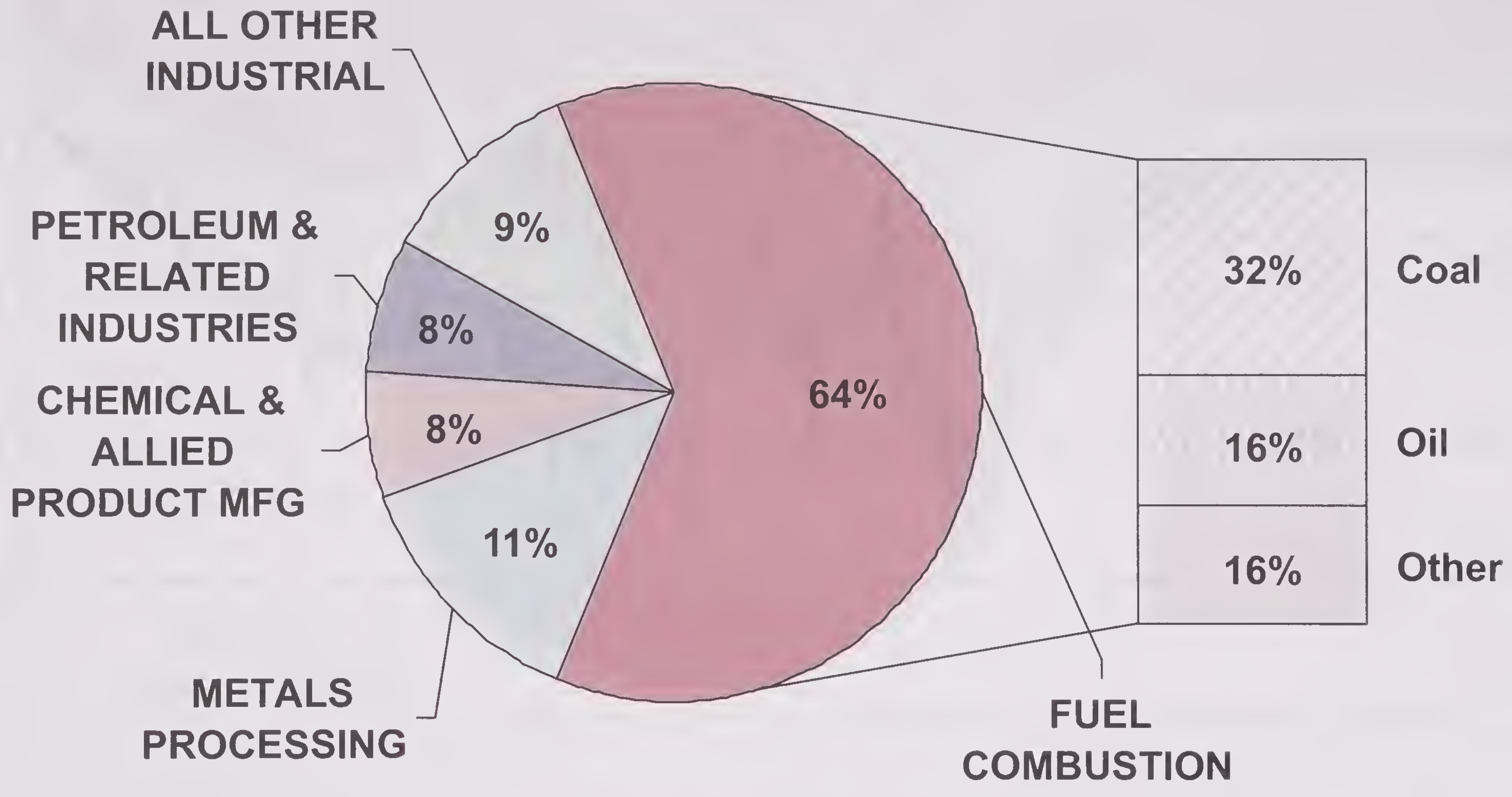
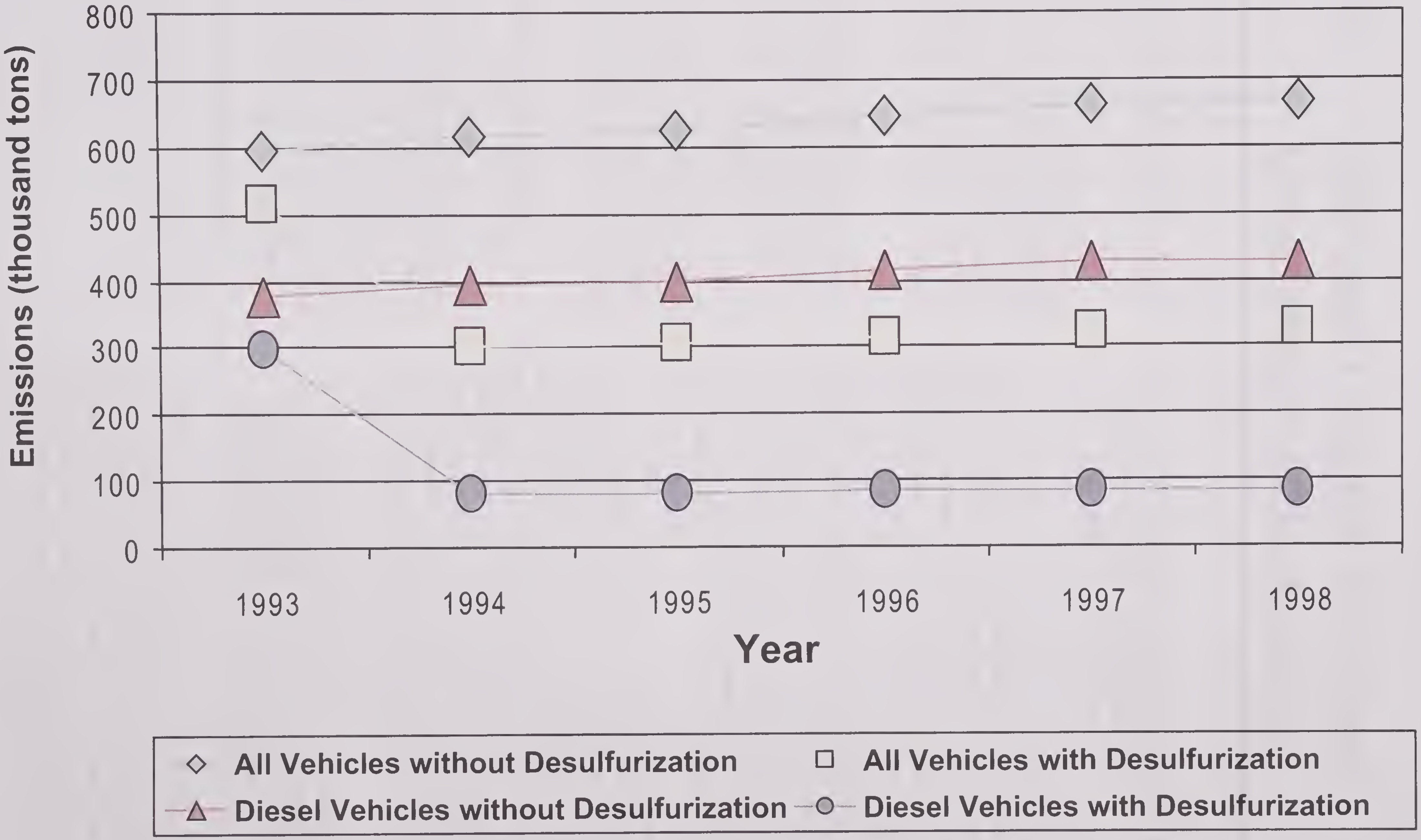


Figure 4-4. SO_2 On-Road Emissions With and Without Desulfurization, 1993-1998



Chapter 5.0 National Criteria Pollutant Estimation Methodologies

5.1 WHAT INFORMATION IS PRESENTED IN THIS CHAPTER?

This chapter provides a list of the source categories in the National Emission Trends (NET) data base whose emission estimation methods have changed since the December 1997 *Trends* report and the years that were affected by the methodology changes. It also provides a brief description of the revised methods used to estimate emissions from these sources.

5.2 WHERE DO I GET INFORMATION ON THE METHODS USED TO ESTIMATE EMISSIONS FOR SOURCES WHOSE METHODS DID NOT CHANGE?

To obtain information on how emissions were estimated for sources not listed in this chapter, you should look in the *Trends* Procedures Document.[1] The *Trends* Procedures Document can be obtained on the Internet using the following website address:

http://www.epa.gov/ttn/chief/ei_data.html#ETDP

In addition to the *Trends* Procedures Document, you should also look at the chapter entitled "Methodologies That Are New" and Appendix B of the *Trends* update document.[2] Methods used to estimate emissions for several source categories were changed last year, and descriptions of the changes are found in the "Methodologies That Are New" chapter of that report. The *Trends* update document can be found on the Internet using the following website address:

http://www.epa.gov/ttn/chief/trends98/emtrnd.html

Table 5-1 provides an overview of all sources whose emission estimation methodologies have changed since publication of the *Trends* Procedures Document.

5.3 WHAT OTHER THINGS SHOULD I KNOW ABOUT THE TRENDS ESTIMATION METHODS?

Each year, the United States (U.S.) Environmental Protection Agency (EPA) compiles emission estimates used in assessing trends in the amounts of criteria pollutants discharged into the air. Prior to 1993, the main purpose of the published trends was to portray relative progress in the control of air pollutant emissions nationally. Those estimates were based on standardized emission inventory procedures using aggregate national economic and demographic data. As interest in, and the need for emission figures for individual States and metropolitan areas increased, it was obvious those techniques lacked the precision needed to provide the detailed data, representative of diverse economic and geographic areas, that could realistically assess emission reduction efforts at these smaller scales.

In recent years, the preparation and presentation of national emission estimates has evolved toward meeting the need for more detailed and more accurate inventories. To achieve this goal, revised methodologies have been developed that support the incorporation of detailed State Implementation Plan (SIP) inventories and/or other regional inventories where available (e.g., Ozone Transport Assessment Group [OTAG], Grand Canyon Visibility Transport Commission [GCVTC], periodic emission inventories [PEI]). In addition to presenting national progress in reducing air emissions, local trends in emissions are now presented when possible.

> *Because of these changes in methodologies, comparison of values with previous **Trends** reports is not a valid exercise. You should use caution when comparing estimates for the years 1985 to 1997 from this report with values in any previous report.*

Table 5-2 provides a general overview of where emission values were obtained for each State, for both point and area sources. Mobile source emissions are estimated by EPA for all States using the MOBILE model. EPA also prepares utility emission estimates. Table 5-3 indicates the source of data for the two most important pollutants emitted by utilities (nitrogen oxides [NO_x] and sulfur dioxide [SO_2]).

5.4 WHAT SOURCE CATEGORIES ARE ESTIMATED USING METHODS THAT DIFFER FROM THE PREVIOUS REPORT?

Table 5-1 provides a synopsis of the sources whose methods have changed since the publication of the last *Trends* report.[1] Some of the sources listed in Table 5-1 were updated during the preparation of emissions for the *Trends* update[2] and were described in the "Methodologies That Are New" chapter and Appendix B of that report. The shaded rows in Table 5-1 indicate source categories that were modified this year and are described in the sections of this chapter that follow.

5.5 HOW WERE EMISSIONS FROM NON-ROAD SOURCES ESTIMATED?

One of the major changes in the methods used to estimate emissions this year was for non-road sources. EPA's Office of Transportation and Air Quality (OTAQ, formerly the Office of Mobile Sources [OMS]) has been working on a model that estimates the emissions from these sources for several years. The April 1999 draft version of the NONROAD model was available for use this year in estimating emissions from this source category (**http://www.epa.gov/otaq/nonrdmdl.htm**).

In large part, emission estimates for volatile organic compounds (VOC), NO_x, carbon monoxide (CO), SO_2, particulate matter (PM) less than 10 microns (PM_{10}), and PM less than 2.5 microns ($PM_{2.5}$) were calculated using the draft version of the NONROAD model, for all gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG) nonroad equipment types at the 10-digit Source Classification Code (SCC) level. There were a few categories that were not calculated using the NONROAD model. The methods used to calculate emissions for those non-road sources are described in section 5.5.4 and 5.5.5. In addition, the NONROAD model does not contain emission factors to calculate ammonia (NH_3) emissions. As a result, NH_3 emissions were calculated outside the model using fuel consumption estimates that were generated from the NONROAD model. The methods used to calculate other pollutants that are not included in the NONROAD model are described in section 5.5.6.

5.5.1 What Types of Sources are Included in the NONROAD Model?

The NONROAD model includes the following general categories:

- agricultural;
- airport support;
- light commercial;
- construction and mining;
- industrial;
- lawn and garden;
- logging;
- pleasure craft;
- railroad; and
- recreational equipment.

The model generates emissions at subcategory levels lower than the general categories listed above. The subcategories are equivalent to 10-digit SCC levels.

5.5.2 What Years Were Estimated?

County-level criteria pollutant estimates for non-road sources were prepared for all years from 1985-1998 inclusive. National emission estimates were calculated for 1970, 1975, and 1980.

5.5.3 Were There Differences in the Methods Used to Calculate Non-road Emissions for Different Years?

Yes. EPA calculated county-level emissions differently for the periods 1985-1995, 1996, and 1997-1998. The methods used to calculate county-level emissions for 1985-1995 and 1997-1998 were identical. Two different methods were used due to time and budget constraints.

EPA calculated criteria pollutant emission estimates for 1996 using the draft NONROAD model adapted to run on a DEC Alpha UNIX workstation. A set of 385 input files was prepared in order to produce an annual county-level non-road emissions inventory for 1996. These input files included a default input file for each State that accounted for average statewide temperatures and seasonal (summer, fall, winter, and spring) Reid vapor pressures (RVP). Emissions for all counties in the United States were calculated using the default State input files. In some cases however, the estimates for particular counties were replaced with county-specific estimates, if those counties had significant differences in their RVP, fuel characteristics due to reformulated gasoline (RFG) and oxygenated fuel requirements, and Stage II controls.

For areas subject to Phase 1 of the Federal RFG program, separate RVP values were modeled in the 1996 NONROAD inputs for May through September. Oxygenated fuel was modeled in the areas participating in this program in 1996. Four seasonal emissions files for each run were then added together, and the records for each State were combined to produce a database of annual and daily emissions.

Ozone season daily emissions were also estimated. Weekday or weekend day emissions must be specified separately when running the NONROAD model (i.e., annual and daily emissions cannot be generated during the same runs). Because of the time involved in preparing county-level estimates for the whole nation, daily emissions were estimated by using the summer season emissions generated by the NONROAD model, divided by 92 days rather than performing an additional set of calculations for weekday or weekend day emissions.

Emissions for 1985-1995 and 1997-1998 were calculated differently than 1996 emissions. The NONROAD model was run at the national level for all relevant inventory years. Each national run included three seasonal (i.e., summer, winter, fall/spring combined) NONROAD model runs per year to estimate annual criteria pollutant emissions. Seasonal runs were performed to account for differences in average seasonal temperature, as well as RVP. Fall and spring were combined since the average seasonal temperature for those seasons is generally equivalent.

Using the results of the national-level runs, we calculated a ratio by dividing national 10-digit SCC-level emission estimates for each year by their equivalent 1996 national values. County-level emissions were estimated for each year by multiplying each ratio times the 1996 county-level, SCC-level emissions. This approach ensures that the sum of all county-level emissions for any year are equivalent to the national-level estimates, but are distributed to the counties according to the 1996 distribution. This approach was utilized due to time and resource constraints.

Because the NONROAD model estimates growth in local equipment populations using one national average growth rate, the effects of growth should be reflected in the national-level runs for each alternate year aside from the base year 1996. The effects of federal non-road emission standards in future years (e.g., years beyond 1996) would also be accounted for. Because the model uses one average growth rate for the whole nation, the approach of using the 1996 county-level inventory as a basis for geographically allocating national inventories for other years was assumed to be reasonable. However, temperature and fuel inputs to reflect local conditions cannot be accounted for when doing a national-level run for a specified year.

As a quality assurance step, category-level emissions generated from the 1996 county-level NONROAD model UNIX runs and summed to the national level were compared with emissions resulting from 3 national, seasonal runs (summer, winter, fall/spring combined). Fall and spring seasonal runs were combined to save resources, since the temperatures for these two seasons are generally similar. This was also done to test the viability of the proposed approach for other years, which rely on national-level runs geographically allocated to the county-level using the 1996 county distribution. If a large disparity existed in the results obtained when running the model at the county-level versus the national level, it could also potentially result in a discontinuity in the emissions data from 1996 to 1997, or from 1995 to 1996. The results of these two separate runs are, in fact, reasonably comparable.

Revised emission estimates were also calculated for 1970, 1975, and 1980. Only national estimates are available for these years. We determined source category-specific ratios of the updated 1985 estimates to the previous Trends values. We then multiplied that ratio times the previous national Trends non-road value for each year to develop revised estimates.

5.5.4 Were There Non-road Emission Sources That Were Not Estimated Using the NONROAD Model?

Yes. Emissions for recreational gasoline powered equipment, aircraft, commercial marine vessels, and locomotives were estimated using other methods. EPA has determined that the draft version of the NONROAD model over estimates the equipment population for recreational gasoline powered equipment, so emissions for that category were estimated using the Trends methods used before introduction of the NONROAD model. For the other non-road emission sources, the NONROAD model does not currently include estimation methods for these categories, so the current Trends method found in the *Trends* Procedures Document was used to develop the emission estimates.[1]

5.5.5 How Were Emissions Estimated for Categories Discussed in Section 5.5.4 Above?

As indicated above, the NONROAD model is still in draft form, and emission estimates for certain categories are still undergoing review. For example, large populations are reported for recreational gasoline equipment. This results in emission estimates that are significantly higher than prior year estimates. For this reason, EPA requested that emission estimates from the existing Trends data base be used in place of the NONROAD model estimates for this category.

Commercial aircraft and general aviation estimates for 1997 and 1998 were developed from 1996 values using updated landing-takeoff operations data from the Federal Aviation Administration (FAA) as growth factors. Military aircraft, unpaved airstrips, and aircraft refueling emissions were grown from 1996 using growth factors consistent with the current draft version of the Economic Growth Analysis System (EGAS).[3] Information on how the 1996 emission estimates for these sources were developed can be found in the *Trends* Procedures Document.[1]

EPA's OTAQ prepared 1995-1998 VOC, NO_x, CO, and total PM national emission estimates for commercial marine diesel engines. PM_{10} was assumed to be equivalent to PM, and $PM_{2.5}$ was estimated by multiplying PM_{10} emissions by a factor of 0.92. These new national estimates were distributed to counties using the geographic distribution in the existing 1996 NET data base [i.e., the National Acid Precipitation Assessment Program (NAPAP) distribution, or the State-supplied distribution, if a State had submitted data under OTAG for these categories]. Commercial marine emissions were not reported under the same SCC for all States in the data base. For example, some States reported commercial marine diesel emissions under the SCC 2280000000, which could potentially include other fuel types (e.g., residual, gasoline). Therefore, a distribution was established based on emissions for all commercial marine SCCs. Because the OTAQ estimates included emissions from residual-fueled vessels, emissions corresponding to this SCC were removed, as well as emissions from the general SCC 2280000000. Sulfur dioxide emissions reported for residual-fueled vessels were not removed, however, since OTAQ did not supply revised emissions for this pollutant.

In addition, records for several States had emissions for some pollutants, including SO_2 and PM_{10}, but no VOC, NO_x, or CO emissions. We estimated the emissions for these pollutants, by using a national average ratio of VOC/PM_{10}, NO_x/PM_{10}, and CO/PM_{10} which were calculated from the available inventory data. These ratios were then applied to the PM_{10} emissions to estimate the missing VOC, NO_x, and CO emissions.

For the years 1985-1994, we calculated the ratio of the 1995 revised OTAQ commercial marine emissions to the previous 1995 Trends emissions values for each pollutant. This ratio was then applied to emission estimates for the following SCCs: commercial marine diesel (2280002), commercial marine residual (2280003), and commercial marine unspecified fuel (2280000). This method was used to avoid a large disparity between existing Trends estimates and revised OTAQ estimates (which were only available back to 1995). We did not perform any additional data augmentation for these years.

1997 and 1998 emission estimates for commercial gasoline, commercial coal, and military marine vessels were grown from 1996 using growth factor values that were consistent with the current draft version of EGAS.

5.5.6 Were Any Pollutant Estimates Prepared Differently for Non-road Sources?

Yes, lead (Pb) and NH_3. Pb was estimated using methods described in section 5.18 of the *Trends* Procedures Document.[1] For NONROAD model categories, NH_3 emissions were calculated for the years 1990-1998, based on county-level fuel consumption estimates obtained from NONROAD model runs. Fuel consumption estimates were not available for LPG and CNG-fueled equipment. Emission factors provided by EPA's OTAQ were then applied to these activity data to estimate NH_3 emissions for gasoline equipment (without catalysts) and diesel-fueled equipment. The emission factors were derived primarily from light-duty on-road vehicle emission measurements, and extrapolated to nonroad engines on a fuel consumption basis.

As indicated above, emission estimates for recreational gasoline equipment were maintained from the previous version of the NET. However, recreational gasoline NH_3 emissions were calculated differently. Recreational gasoline equipment NH_3 emissions were calculated based on the NONROAD model fuel consumption estimates. These estimates were then redistributed to existing NET records. This was done to avoid having records in the inventory that only contained NH_3 estimates, since many of the SCCs reported in the NONROAD model for this category were not present in the existing Trends inventory. In addition, many States had previously reported these emissions under the general SCCs 2260001000 (all 2-stroke gasoline recreational vehicles) and 2265001000 (all 4-stroke gasoline recreational vehicles), instead of the more specific recreational equipment types.

For aircraft, commercial marine, and locomotive categories, national fuel consumption estimates for 1996 were obtained from various sources. Jet fuel and aviation gasoline consumption for general aviation and commercial aircraft were obtained from the "FAA Aviation Forecasts Fiscal Years, 1998-2009."[4] For aircraft categories, NH_3 emission factors developed for diesel engines were applied to all fuel consumption estimates, since aviation gasoline consumption was determined to be relatively small compared to jet fuel, and the aircraft SCCs are not defined by fuel type. Diesel consumption estimates for locomotives were obtained from "Locomotive Emission Standards - Regulatory Support Document (RSD)."[5] For commercial marine, data for distillate and residual fuel oil were reported in "Fuel Oil and Kerosene Sales."[6]

To develop NH_3 emissions for 1997 and 1998, 1996 base year NH_3 emissions for these categories were projected for these categories using growth factors. SO_2 emissions were not supplied by OTAQ for commercial marine and locomotives, and estimates for this pollutant were projected using growth factors as well. NH_3 emissions were reported in the NET database for commercial marine and locomotive categories for historic years (i.e., 1990-1995); no changes were made to these historic estimates. Historic NH_3 emissions were not available for aircraft, so there is a disparity between 1995 and 1996 for NH_3 emissions for this category.

Once annual NH_3 emissions were calculated, summer season daily emissions were estimated using seasonal profiles available from the 1985 NAPAP study. SCC-specific summer seasonal fractions were applied to the annual emissions to generate summer season emissions, which were then divided by 92 days to estimate summer season daily emissions.

5.6 WHAT CHANGES WERE MADE IN THE METHOD USED TO ESTIMATE NONUTILITY POINT AND AREA SOURCE EMISSIONS?

EPA has tried over the last several years to ensure that the NET data base reflects State developed emission estimates whenever feasible. For example, 1990 NET emission estimates include State-developed data from OTAG and GCVTC inventories. Emissions for years following 1990 were supplemented with data from the Aerometric Information Retrieval System (AIRS). PEI and annual submission of emissions data for major point sources are required under the CAAA. As part of the PEI requirements, States containing nonattainment areas (NAAs) needed to submit a PEI for 1996. Consequently, one of EPA's goals was to include data developed by the States as part of the 1996 PEI effort in the NET. While the CAAA only requires submittal of ozone pollutant data for the PEI requirements, annual point source reporting is designed to cover all pollutants. Additionally, in the guidance provided to the States on the PEI submittal process, EPA encouraged States to submit emission estimates for all pollutants, since the NET contains estimates for all criteria pollutants and is to be the ultimate repository of the State data. To reduce the burden of preparing this inventory, EPA gave each State a copy of the 1996 NET inventory as a starting point in preparing their 1996 PEI.

In the past, EPA has estimated emissions for this group of sources by growing emissions using growth factors derived from the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). As mentioned above, some data derived from AIRS was also used to supplement the emissions in certain years.

5.6.1 What Steps Were Required to Incorporate State PEI Data Into the NET?

The incorporation of the 1996 State/Local emission inventory data is a five step process:

- Data Collection;
- Quality Control (QC);
- Data Augmentation;
- Quality Assurance (QA); and
- Data Loading.

In the data collection step, EPA solicited PEI and annual point source data from the States. There were four acceptable formats States could use to submit their data: 1) the NET Input Format, 2) through AIRS/AIRS Facility Subsystem (AFS), 3) the Electronic Data Interchange X.12 format, and 4) the NET Overwrite Format.

In the QC step, EPA evaluated the data received to ensure that States had correctly characterized, on the 1996 Emission Inventory Submittal Form, the data they submitted (e.g., geographic coverage, pollutants, SCCs, annual and daily emissions), that the data were formatted correctly; that mandatory data elements were included, and the priority SCCs needed to incorporate the data were present (e.g., nonutility point and stationary area source SCCs). Any problems found were followed-up by a phone call to the State/local agency for review and resolution. If basic problems could not be resolved, the data were not included in this version of the NET. Data not included in this version of the NET will be incorporated in FY 2000.

In the data augmentation step, data elements required for the regional scale modeling or this report, that were not supplied in the State data set, were added to the NET. EPA needs a complete inventory containing VOC, NO_x, CO, SO_2, PM_{10}, $PM_{2.5}$, and NH_3. We added emission estimates to the NET for any of these pollutants if they were not included in the State submitted data. Each data element was characterized as "mandatory submission" or "data can be augmented." As part of the QC step, all data received was checked to ensure that data elements classified as mandatory submission were included in the data supplied by the States.

In the QA step, data were checked for reasonableness. QA reports highlighting questionable data were developed and sent to the States for review. Questionable data were either confirmed by the State as correct, corrected by the State, or in the case where the State did not respond, replaced using the data augmentation methods. The QA reports that were sent to States for review included:

- Tier 2 Summary;
- Top 20 Plants for Each Pollutant with Comparison to Current Data;
- NET Plants Not in the State Data;
- Geographic Coordinate Exceptions;
- Stack Parameter Exceptions; and
- Large Sources Without Emission Controls.

In the data loading step, EPA loaded State data that met the QA criteria, or was resolved during the QA step, into the NET data base. This resulted in a fully revised 1996 point and area source file.

5.6.2 How Many States Submitted Data for the 1996 PEI Effort?

Point source data for 34 States and area source data for 13 States was received as part of the PEI data incorporation effort. Figure 5-1 is a map of the United States that indicates which States provided 1) point source data that were utilized, 2) point source data that were not utilized at this time due to data quality problems, 3) point and area source data that were utilized, and 4) no data.

For the majority of States, the PEI point source submittals were made to the AFS. Some States submitted data in alternative formats, primarily using the NET Input Format.

5.6.3 Were Any State-Supplied Data Rejected in the QC Phase?

Yes. A few States' data were rejected either due to problems with data completeness, data format, or both. EPA is working to resolve these problems with the individual States and hopes to include data from these States in the next release of the NET. These States are indicated in Figure 5-1 as States whose data will be processed in 2000.

5.6.4 What Types of Data Were Augmented in the Data Augmentation Step?

As mentioned above, the NET contains emission estimates for all criteria pollutants (except Pb). Thus data elements and/or pollutant emissions that were missing in the State provided data needed to be augmented. The data augmentation procedure included augmenting information related to stack parameters (height, diameter, velocity, flow, temperature), location information (latitude and longitude), operating schedule (hours per day, days per week, hours per year, seasonal throughput), and emission estimates for pollutants not included in the State submittals. A detailed list of the items augmented in the data augmentation phase and the individual steps taken to augment the various data elements is provided in Barnard et. al.[7] and in the draft *Trends* Procedures Document currently being revised.[8]

5.6.5 What Quality Assurance Steps Were Taken to Ensure That the State Data Were Incorporated Correctly?

Quality assurance was an essential element of the data incorporation process. Extensive internal review of the data was performed to ensure that the data were retrieved and formatted correctly and that the data augmentation process was performed correctly. On-going reviews were made of the data to ensure that there were not duplicate records, that emissions values were not "out of range", and that the values for stack parameters were within normal operational values.

The most important part of the QA program was State review of the retrieved and augmented data. EPA prepared a review package for each State submitting data. The review package consisted of a number of reports and tables showing a variety of information about the preliminary data set.

In the past, QA of the NET inventory focused almost exclusively on the emission estimates. Due to the NET's change in focus to a modeling inventory, QA of the NET was expanded to cover additional data elements including stack parameters, geographic coordinates, emission control data, and operating schedule data.

To QA stack parameters, upper and lower limits were developed for each stack parameter carried in the NET. The Stack Exception Report in the QA package listed stacks in the NET where one or more of the parameters was above the upper bound or below the lower bound. High and low values not corrected by the States were replaced with the corresponding upper or lower bound value. The acceptable ranges for each stack parameter are listed below:

Height	0 ft to 1,250 ft
Diameter	0 ft to 50 ft
Temperature	32°F to 2,250°F
Velocity	0 ft/sec to 650 ft/sec

To QA geographic coordinates, maps were generated for each State showing any facilities that were located outside of their State borders when plotted using the geographic coordinates supplied by the State. Coordinates not corrected by the States were replaced with the coordinates for the county centroid based on the State and county codes provided by the State.

5.6.6 What Did EPA Do With Comments Received by the States?

In the early review of the data, several States indicated that the emissions for their ozone precursor pollutants were not correct. The original downloads from AFS were designed to retrieve the default emissions value. However, several States indicated that they typically stored emissions data in one of the alternative emission fields. As a consequence, EPA surveyed the States that submitted data to determine which States submitted emissions data in something other than the default emissions field. Data for those States was retrieved a second time and augmented as required. The emissions for those States were re-summarized and sent back to the States for a final review.

Once comments from all of the review packages were received, modifications to the emissions or process data were made based on the State comments. Modification to the AFS PEI data were made to reflect either new data from the additional downloads, modifications based on the review packages sent out to the States, or based on data that remained anomalous (e.g., stack flow rates).

One portion of the State review package was a list of plants not included in the PEI submittals that were in the version of the 1996 NET provided to the States as a starting point for PEI preparation. Several States provided comments on that table indicating that 1) some or all of these facilities should be maintained, and 2) indicating that while they should be maintained, the emissions should be modified to reflect more accurate State-supplied values. The data for these plants were extracted from the NET and maintained in a separate file.

Since the review packages only provided plant totals, ratios of old to new plant emissions were used to adjust the values of each segment's emissions and then the data were updated in the file.

5.6.7 Was There Any Additional Data Augmentation?

Yes. In addition to criteria pollutants, the NET also houses estimates of NH_3 emissions. None of the States submitting PEI data submitted NH_3 emissions. As a consequence, the NH_3 emissions from the 1996 NET needed to be added back into the revised data base. Two steps were taken to perform this augmentation. First, plant-level total NO_x emissions were calculated for the PEI data submitted by the States. Then plant-level summaries of NH_3 from the NET were developed. Where a match could be made using the State Federal Information Processing Standards (FIPS) code, county FIPS code, and plant identification (ID) code, segment-level emissions for NH_3 were calculated using the following equation:

$$NH_3seg = (NO_xseg/NO_xplant) * NH_3plant$$

where:

NH_3seg = segment-level NH_3 emissions
NO_xseg = PEI segment-level NO_x emissions
NO_xplant = PEI plant-level NO_x emissions
NH_3plant = NET plant-level NH_3 emissions

In order to maintain the NH_3 totals currently in the NET, NH_3-only plant/segment-level records were added for those facilities that did not match plants in the PEI submitted data.

5.6.8 Were There Emissions From Any Sources Submitted by the States That Were Not Incorporated into the NET?

A few source categories were not updated using State-supplied PEI data. These source categories were not updated because EPA feels that the consistent methodology and the quality of the data involved in the calculation of emissions from these categories is at or above that provided by the States. For point sources, State-supplied utility emissions data for segments with SCCs beginning with 101 were not retained. For area sources, the categories not included from State data were on-road mobile and non-road. This approach will be revised in 2000, as data issues are resolved between the States and EPA for the utility and mobile categories.

5.6.9 How Were Nonutility Point and Area Sources for 1997 and 1998 Developed?

The PEI data incorporation effort was only for 1996 emissions. Thus, EPA had to develop 1997 and 1998 emissions internally. Emissions for nonutility point sources and many area sources were developed using growth factors.

To develop 1997 and 1998 emission estimates, EPA compiled a set of emission growth factors to apply to the 1996 NET inventory. For the most part, these growth factors were developed using procedures that are similar to those used by EGAS.[3] The current, publically available version of EGAS is version 3.0. Because EGAS version 3.0 was released in 1995, EPA has recently been working to develop an EGAS Version 4.0. The growth factors used for developing 1997 and 1998 estimates were developed using the draft version of EGAS 4.0. As part of the EGAS version 4.0 development effort, EPA has obtained more recent data/models and updated some of the underlying EGAS files. Two of the major changes that EPA has been performing are: (1) incorporating new economic models from Regional Economic Models, Inc. (REMI); and (2) revising the EGAS 3.0 crosswalk that is used to assign REMI model-derived growth factors to SCCs. The REMI models, which included 72 modeling regions in EGAS 3.0, cover the continental United States. While many modeling regions cover an entire State, some States have separate models for ozone NAAs and rest-of-state areas. For this effort, updated REMI models were available that provide historical (through 1996) and forecast (through 2035) socioeconomic data for each of 75 modeling regions in the United States (three new modeling regions were added in North Carolina).[9] As part of the revisions to the EGAS 3.0 crosswalk, EPA reviewed each of the previous SCC assignments and incorporated new assignments for over 2,600 additional SCCs.

The EPA applied REMI model-derived growth factors to point sources at the Standard Industrial Classification (SIC) code-level whenever SIC code information was available in the inventory. Because REMI's models provide output for 172 economic sectors, which are roughly equivalent to 3-digit SIC codes, REMI output was first directly matched to the SIC code information available from the point source component of the NET inventory. For some point source records, SIC code information was missing, available at less than a 3-digit SIC code level, or invalid (did not represent a valid SIC code). For these point source records, EPA assigned REMI model-derived growth factors to SCCs using the revised EGAS crosswalk. Because the REMI models do not include Alaska and Hawaii, it was necessary to utilize a different source of projections data for these States. The BEA released a set of gross State product (GSP) projections in 1995.[10] These projections, which are generally available at a 2-digit SIC code level, were used to develop growth factors for Alaska and Hawaii. The BEA-derived growth factors were first matched with point sources in the inventory at the 2-digit SIC code level. For point sources with missing/invalid SIC code information, and for all area sources, EPA matched BEA data with emission sources using an updated EGAS 3.0 crosswalk matching BEA sectors with SCCs.

EGAS 3.0 includes a number of models that project energy consumption by sector and fuel type (e.g., residential natural gas consumption). The revisions to the energy consumption modules in EGAS 3.0 have not yet been completed. Because these updates are expected to include the use of Department of Energy (DOE) energy projections data, EPA compiled the DOE's forecast data for use in adjusting the REMI/BEA data for projected changes in energy intensity.[11] Specifically, the EPA calculated the following national energy intensity factors for 1996, 1997, and 1998:

- Residential fuel combustion - projected delivered energy by fuel type divided by projected residential floor space;
- Commercial/institutional fuel combustion - projected delivered energy by fuel type divided by projected commercial floor space; and
- Industrial fuel combustion - projected delivered energy by fuel type for both specific industries (e.g., refining industry) and for total industrial fuel use divided by projected constant dollar industrial output (specific industry or total industrial output).

Next, EPA calculated the ratios of national 1996 energy intensity to both the national 1997 and 1998 energy intensity for each sector/fuel type. For residential natural gas consumption, for example, EPA developed 1996:1997 and 1996:1998 ratios of residential natural gas consumption per square foot of residential floor space. These ratios were then used to adjust the EGAS modeling region-specific REMI/BEA population-based residential fuel consumption growth factors.

Finally, for VOC emissions, controls were implemented for several maximum achievable control technology (MACT) sources. If a source category was subject to MACT in either 1997 or 1998, the 1996 control efficiency for that source was compared with the control efficiency that the MACT control would have on VOC. If the 1996 control efficiency was greater than or equal to the MACT control efficiency then the data was maintained at the 1996 level. If the 1996 control efficiency was lower than the MACT standard, then uncontrolled emissions were back-calculated using the 1996 control efficiency and then controlled emissions were calculated from the uncontrolled levels using the MACT control efficiency. The MACT control efficiency value was also inserted into the data base field for control efficiency. It was assumed that the MACT controls operated for the entire year, even if they were not scheduled to come on-line until the middle to latter part of the year.

5.7 WHAT OTHER METHODOLOGY CHANGES WERE THERE?

Methodology changes or changes in the underlying data used to calculate emissions were made for agricultural livestock, structural fire, and prescribed burning emissions. In addition, corrections were made in how on-road mobile NO_x emissions were calculated to account for the heavy-duty NO_x defeat device on heavy-duty diesel engines. (See Section 5.7.4.)

5.7.1 What Changes Were Made in How Agricultural Livestock Emissions Were Calculated?

EPA had calculated PM and NH_3 emissions from agricultural livestock sources using U.S. Department of Agriculture (USDA) Census of Agriculture data on animal populations. The Census of Agriculture is conducted every 5 years. Thus, we had been required to develop a methodology that could be used to estimate emissions in years between the publication of the Census of Agriculture data. EPA used BEA State-level farm sector growth factors to estimate emissions for the years between Census of Agriculture publications. For the time period that EPA had estimated emissions from this source category (1990-1997) only one Census of Agriculture publication had been prepared (1992). The 1997 Census of Agriculture was released in the spring of 1999. An evaluation of the actual statistics on livestock populations following release of the 1997 Census of Agriculture indicated that the livestock population data for 1997 was very similar to the 1992 data. However, the NET inventory had shown approximately a 25 percent drop in total NH_3 emissions from 1992 to 1997 which was due almost entirely to an approximately 40 percent drop in emissions in the livestock category. Apparently agricultural commodity prices dropped between 1992 and 1997, but livestock populations stayed more or less stable. Since the BEA statistics use commodity prices rather than animal population data, the post-1992 inventories would be underestimated.

Thus EPA decided that the emission estimates for this source category should be revised using more appropriate data on animal populations. The 1987 Census of Agriculture data were obtained and in conjunction with the 1992 and 1997 data a linear estimation method was developed to predict animal populations for intermediate years and to project to 1998. The linear estimates developed were State and animal specific. In some cases, development of the linear regression used to estimate animal populations resulted in negative values. In those cases, the animal population was set to zero.

Using the revised animal population data with the current emission factors[1], revised estimates were developed. The changes only affected NH_3 and PM emission estimates.

5.7.2 What Changes Were Made in How Structural Fire Emissions Were Calculated?

EPA has an on-going program to improve the quality of emission estimates. That program, the Emission Inventory Improvement Program (EIIP) routinely evaluates the methods used to estimate emissions from various sources. Recent work by the EIIP had identified a revision to the loading factor used to estimate emissions from structural fires. The revised value for the loading factor was obtained from the California Air Resources Board.[12]

Using the revised loading factor, emission estimates were revised starting with 1990. Since several States submitted data for this source during the OTAG data collection process, revised and updated 1990 emission estimates for this source were developed by EPA only for non-OTAG States. Once the 1990 estimates were revised, 1991-1995 estimates were calculated by using a growth factor developed for the on-going revision to EGAS. The growth factor for the revised version of EGAS was developed using a regression equation that relates national population to the amount of material burned in structural fires. State-level population is then used as an input to predict the amount of material burned in each State, using the regression equation. Both OTAG and non-OTAG estimates were grown.

Estimates for 1996 were developed using updated activity data and the California Air Resources Board's loading factor for non-OTAG states. OTAG States were grown using the EGAS growth factors. Then, as part of the 1996 PEI data incorporation effort, 1996 emissions were replaced by State-supplied data obtained during the PEI effort.

Estimates for 1997 and 1998 were developed identically to how the base 1996 data were developed, except that there was no replacement with State-supplied data, since there was no equivalent to the PEI data for those years.

5.7.3 What Changes Were Made in How Prescribed Burning Emissions Were Calculated?

EPA updated prescribed burning emissions estimates to better reflect data now available with which to calculate growth in this sector. In earlier versions of the NET, emissions for prescribed burning were grown using population as a surrogate. EPA felt that population was not an appropriate growth surrogate for prescribed burning. A method developed for the Section 812 Prospective[13] study which held private land acreage constant, but develops a growth index for public lands based on national statistics for acres burned, was initiated this year. The technique uses 1990 estimates as a base year, since values for 1990 include actual data for a number of States, especially those in the GCVTC inventory.

EPA used information on the fraction of public including State-owned and private land from the Section 812 Prospective study to allocate a portion of the emissions to each of these components. Then, a national ratio of acres burned on public lands was developed using U.S. Forest Service data.[14] Growth factors were then developed by calculating a ratio for the year of interest relative to 1990 (the base year). The growth factor was then multiplied by the fraction of emissions attributable to public lands. This value was then added back to the remaining emissions (i.e., those attributable to private lands) to obtain the emissions for each year. This is a rough estimate. The actual number of acres burned each year varies greatly and is a function of fuel moisture, fuel density, meteorology, and other factors.

5.7.4 How Did EPA Account for Emissions from Heavy-Duty Diesel Engines that Used the NO_x Defeat Device?

On October 22, 1998, EPA reached a settlement agreement with seven manufacturers of diesel truck engines. EPA had found that the engines in as many as 1.3 million trucks built over the last 10 years had devices that defeated pollution controls. Those allegations were related to excessive NO_x emissions during highway driving that were not occurring during engine certification testing. The engine electronic control module would switch to those fuel-efficient, but high NO_x, operation modes during highway driving. Federal officials considered such engine control software "defeat devices", which are illegal under the federal laws.

For purposes of this report, a defeat device is a vehicle component or software which allows excess emissions to be produced during operating modes which are not explicitly covered by a certification test while still controlling emissions during the certification test. In the case of the heavy-duty NO_x defeat device, the device was active (shut off emission control systems) during steady-state operating modes such as cruising down the freeway, but was mostly inactive during transient operation. It was built into heavy-duty diesel vehicles (HDDVs) beginning in the 1988 model year, and completely removed by the 2000 model year. In the late 1980's and early 1990's the defeat device was being phased into the fleet and was mostly confined to the heavy end of the heavy-duty diesels (8a and 8b vehicles). However, by the mid to late 1990's it was widespread on virtually all of the heavy end engines and most of the medium and light end heavy-duty diesels.

EPA's MOBILE model used to calculate emissions from on-road vehicles is designed based on engine certification testing. Thus, the use of the defeat devices by HDDVs caused the emission factors calculated by those models to underestimate emissions from these vehicles. In order to determine that actual emissions arising from the use of these devices, EPA developed a series of spreadsheet models to provide corrected emission factors for heavy-duty vehicles that would account for the underestimated emissions.[15] EPA's OTAQ spreadsheets contain multiplicative factors representing the ratio of HDDV NO_x emissions with the defeat devices to the HDDV NO_x emissions without the defeat devices. These factors differ by calendar year, roadway type, and vehicle speed. The HDDV NO_x emissions, calculated using the MOBILE5b HDDV NO_x emission factors, were revised by multiplying the appropriate factor at the State/county/roadway type level of detail for the years 1990 through 1998. Additional details on the spreadsheet models can be found at the following website address:

http://www.epa.gov/OMSWWW/m6.htm

5.9 REFERENCES

1. "National Air Pollutant Emission Trends Procedures Document, 1900-1996," EPA-454/R-98-008. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. May 1998.
2. "National Air Pollutant Emission Trends Update, 1970-1997," EPA-454/E-98-007, U.S. Environmental Protection Agency, Research Triangle Park, NC. December 1998.
3. "Economic Growth Analysis System: Version 3.0," software, reference manual, and user's guide, U.S. Environmental Protection Agency. Available for download from **http://www.epa.gov/ttn/chief/ei_data.html#EGAS**. August 1995
4. "FAA Aviation Forecasts Fiscal Years, 1998-2009," Office of Aviation Policy and Plans, Federal Aviation Administration. March 1998.
5. "Locomotive Emission Standards - Regulatory Support Document (RSD)," Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, MI. April 1997.
6. "Fuel Oil and Kerosene Sales," DOE/EIA-0380, Energy Information Administration, U.S. Department of Energy, Washington, DC. 1996.
7. Barnard, W.R., C. Walvoord, S. Nizich, R.L. Tooly, and D. Solomon, "Incorporation of State Emissions Data into the National Emission Trends Data Base," presented at the Air & Waste Management Association Specialty Conference, *The Emission Inventory: Regional Strategies for the Future*, Raleigh, NC. October 1999.
8. "National Air Pollutant Emission Trends Procedures Document, Current Methods for Historic and Projection Year Emission Estimates," Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. Draft, in preparation.
9. "EPA EGAS EDFS-14 Multi-Region County Models," Nine DOS Models Covering the U.S., Last History Year 1996, Regional Economic Models, Inc., CD-ROM. February 18, 1999.
10. "Regional Projections to 2045," Volumes 1, 2, and 3, Bureau of Economic Analysis, U.S. Department of Commerce, Washington DC. July 1995.
11. "Annual Energy Outlook 1999, with Projections through 2020," DOE/EIA-0383(99), Office of Integrated Analysis and Forecasting, Energy Information Administration, U.S. Department of Energy. December 1998.
12. "Emission Inventory Procedural Manual, Volume III: Methods for Assessing Area Source Emissions," California EPA: Air Resources Board. 1994.
13. "The Benefits and Costs of the Clean Air Act 1990 to 2010," EPA Report to Congress, EPA-410-R-99-001, U.S. Environmental Protection Agency. 1999.
14. "Forest Statistics of the United States, 1987," USFS publication, PNW-RB-168, U.S. Forest Service. September 1989.
15. "Development and Use of Heavy-Duty NO_x Defeat Device Emission Effects for MOBILE5 and MOBILE 6," EPA420-P-99-030, U.S. Environmental Protection Agency. October 1999.

Table 5-1. Emission Estimation Methods That Have Changed Since the Last Report

Year of Inventory	Pollutant	Category	Methodology Change*
1990	CO, VOC, NO_x	Primarily nonutility point sources and 17 states worth of area sources	A combination of Ozone Transport Assessment Group (OTAG), Grand Canyon Visibility Transport Commission Inventory (GCVTC), and Aerometric Information Retrieval System (AIRS) data was added to inventory, replacing some units but primarily just adding more units. (Ozone season daily data received was developed into annual data).
1990	PM_{10}, $PM_{2.5}$, SO_2	As above	State data received as above was augmented with PM and SO_2 data through an SO_2 and PM to NO_x uncontrolled emission factor ratio.
1991-1995	All but Pb	Primarily nonutility point sources and 17 states worth of area sources	NAPAP, AIRS data, GCVTC and Grand Canyon projections from the 1990 inventory using Bureau of Economic Analysis (BEA) growth indicators.
1990	All but Pb	on-road mobile	1990, 1995, 1996 use state-supplied MOBILE model inputs where applicable. See Reference 1 for a list of States supplying model inputs.
1990	All but Pb	on-road mobile	Used state supplied vehicle miles traveled (VMT) where applicable. See Reference 1 for a list of States providing VMT.
1985-1989	All but Pb	chemical and allied	Removed rule effectiveness from pre-1990 chemical and allied product emissions.
1985-1994	NO_x	utilities	Used NO_x emission rates from Acid Rain Division (ARD) instead of AP-42 emission factors.
1994-1998	NO_x, SO_2	utilities	Based Phase I units on CEM data from ARD, remaining units are from DOE767 survey data (small amount of units).
1996	All but Pb	nonutility point (35 states) and area sources (14 states)	Added state-supplied data directly received from states or retrieved from AIRS as part of the PEI inventory effort, as directed by the states. 5 State submittals were select cities only.
1997-1998	All but Pb	nonutility point and area sources	Projected through 1998 based on the 1996 PEI enhanced database using EGAS derived growth factors and BEA growth factors where applicable.
1970, 1975, 1980	All but Pb	non-road sources	Generated national-level nonroad emission estimates based on category-specific ratios of 1996 NONROAD model outputs to previous year national estimates.
1985-1998	All but Pb	non-road sources	Ran the beta version of the NONROAD model for all counties in U.S. for 1996. Used the NONROAD model to calculate national emissions for the other years and then used SCC-specific ratios for the other years relative to 1996 (year in question/1996) to determine county-level estimates.
1985-1998	All but Pb	non-road sources	For commercial marine diesel, EPA's OTAQ provided revised national VOC, NO_x, CO, and PM emission estimates for commercial marine diesel engines. National estimates were distributed to counties using the geographic distribution in the existing NET.
1990-1998	All but Pb	Miscellaneous-agric. forestry	Revised allocation of Census of Agriculture activity data between the 1990 and 1997 census: used agricultural surrogates instead of economic surrogates.
1990-1998	PM	Miscellaneous -agric. crops	Began using tillage activity data using the Conservation Technology Information Center, Purdue University, data, and also changed silt value methodology from 1990 onward.
1989-1998	PM	Miscellaneous-managed burning	Based on USDA Forest Service inventory of PM from prescribed burning. Public percentage of acres burned projected from 1990 using national-level growth factor developed from total U.S. acres burned, while private portion held constant.
1990-1998	PM	Miscellaneous -construction	Changed the emission factor in 1990: changed from using a former AP-42 value to using latest AP-42 findings report: "Improvement of Specific Emission Factors" - change occurred in Trends year 1997.
1990-1998	PM	paved roads	The rain correction factor in the paved road equation was reduced by 50 percent for the years 1990 onward due to uncertainty associated with the actual reduction in emissions due to precipitation on paved road surfaces.
1990-1998	All but Pb	structural fires	For non-OTAG States, revised 1990 and 1996 emissions based on new loading factor value. Projected all States using EGAS regression equations, which relate State-level population to the amount of material burned in structure fires.

* For a list of specific data sources used for each State, please see Section 4.1 of reference 8.

Table 5-2. Point and Area Source Data Submitted

	Point Sources		Area Sources	
State	**Source**	**Adjustments to Point Source Data**	**Source**	**Adjustments to Area Source Data**
Alabama	PEI		PEI	Birmingham NAA Only
Alabama	OTAG	Backcast to 1990 using BEA. Average Summer Day estimated using methodology described.	NAPAP	
Arizona	NAPAP		NAPAP	
Arkansas	OTAG	Average Summer Day estimated using default temporal factors.	NAPAP	
California	PEI		PEI	
Colorado	PEI		NAPAP	
Connecticut	PEI		PEI	
Delaware	PEI		PEI	
Florida	PEI		OTAG	Added Non-road emissions estimates from Int. Inventory to Jacksonville (Duval County).
Georgia	PEI	Only Atlanta not statewide	PEI	Only Atlanta not statewide
Georgia	OTAG	Average Summer Day estimated using default temporal factors.	OTAG	
Idaho	NAPAP	PEI data submitted but not incorporated into NET inventory.	NAPAP	PEI data submitted but not incorporated into NET inventory.
Illinois	PEI		OTAG	
Indiana	PEI		PEI	
Iowa	NAPAP		NAPAP	
Kansas	PEI		NAPAP	
Kentucky	PEI		OTAG	
Louisiana	PEI		PEI	
Maine	PEI		OTAG	
Maryland	PEI		PEI	
Massachusetts	PEI		NAPAP	
Michigan	PEI		OTAG	
Minnesota	OTAG	Average Summer Day estimated using methodology described above.	NAPAP	
Mississippi	NAPAP		NAPAP	
Missouri	PEI	Only partial state.	PEI	St. Louis NAA Only
Missouri	OTAG	Backcast to 1990 using BEA. Average Summer Day estimated using methodology described above.		
Montana	PEI		NAPAP	
Nebraska	PEI		NAPAP	
Nevada	NAPAP		NAPAP	
New Hampshire	PEI		OTAG	
New Jersey	OTAG		OTAG	
New Mexico	NAPAP		NAPAP	
New York	OTAG		OTAG	
North Carolina	PEI		OTAG	Average Summer Day estimated using default temporal factors.
North Dakota	PEI		NAPAP	
Ohio	OTAG	Average Summer Day estimated using methodology described above.	OTAG	Assigned SCCs and converted from kgs to tons. NO_x and CO from Int. Inventory added to Canton, Dayton and Toledo counties.
Oklahoma	PEI		PEI	

Table 5-2 (continued)

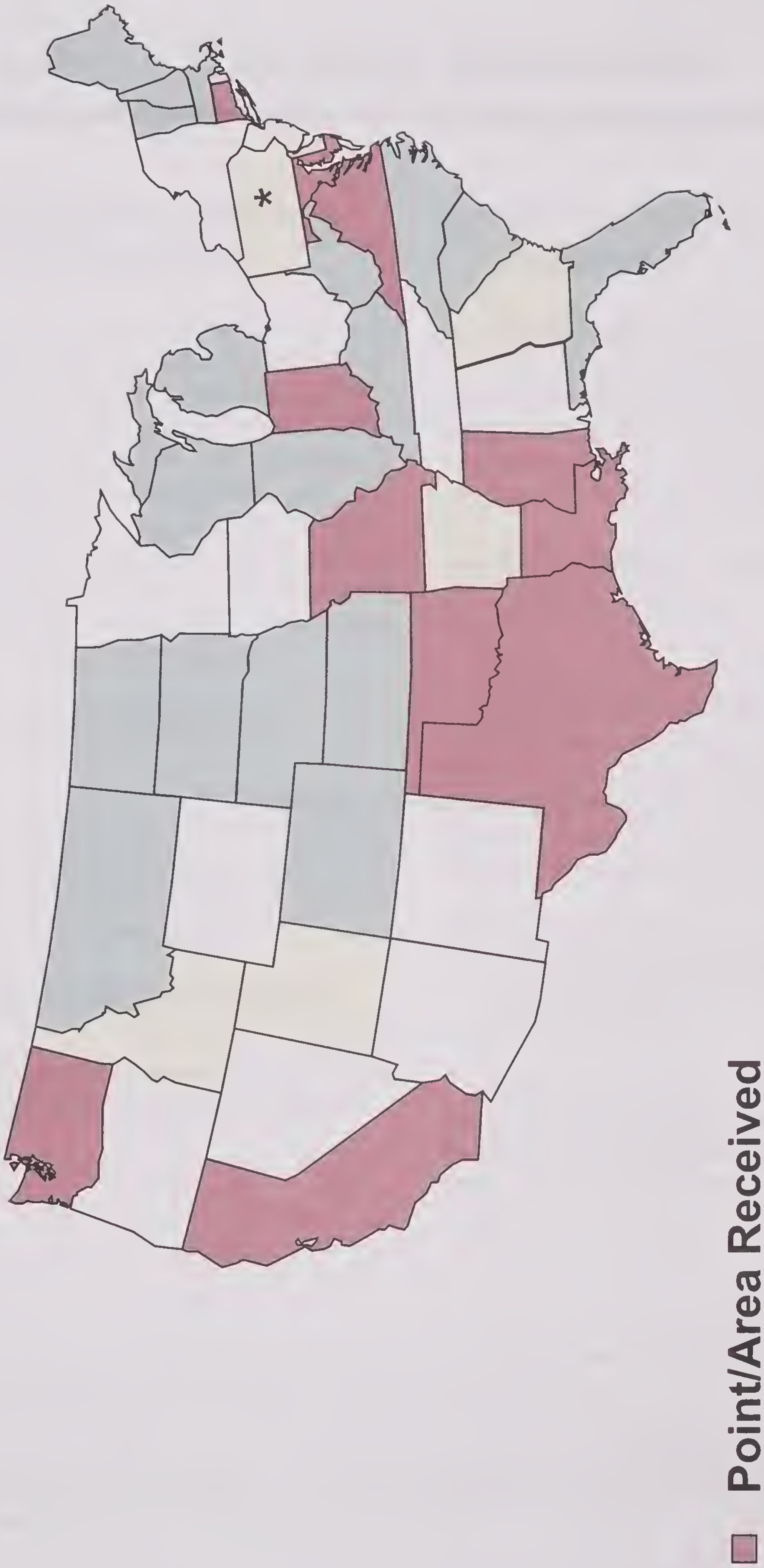
	Point Sources		Area Sources	
State	**Source**	**Adjustments to Point Source Data**	**Source**	**Adjustments to Area Source Data**
Oregon	GCVTC		GCVTC	
Pennsylvania	PEI	Allegheny and Philadelphia Counties Only	PEI	Allegheny and Philadelphia Counties Only
Pennsylvania	OTAG		OTAG	Non-road emissions submitted were county totals. Non-road emissions distributed to specific SCCs based on Int. Inventory
Rhode Island	OTAG		OTAG	
South Carolina	PEI		NAPAP	
South Dakota	PEI		NAPAP	
Tennessee	OTAG	Average Summer Day estimated using default temporal factors.	OTAG	No non-road data submitted. Non-road emissions added from Int. Inventory.
Texas	PEI		PEI	NAAs Only (Houston, Beaumont, Dallas, El Paso)
Utah	NAPAP		NAPAP	
Vermont	PEI		OTAG	
Virginia	PEI		PEI	
Washington	PEI		PEI	
West Virginia	PEI		OTAG	
Wisconsin	PEI		OTAG	
Wyoming	NAPAP		NAPAP	

NOTE(S): Year of Inventory is 1996 for PEI, 1990 for OTAG and GCVTC, and 1985 for NAPAP

Table 5-3. Utility Boiler Emissions Data Sources for NO_x and SO_2 by Year

Year	NO_x	SO_2
1985	Overlaid Acid Rain Division (ARD) coal NO_x rate calculations when possible	NADBV311 data
1986	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1987	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1988	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1989	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1990	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1991	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1992	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1993	Overlaid ARD coal NO_x rate calculations when possible	Calculated from EIA-767 data
1994	Overlaid ARD coal NO_x rate calculations when possible; overlaid ETS/CEM data when possible	Calculated from EIA-767 data
1995	Overlaid ETS/CEM data when possible	Overlaid ETS/CEM data when possible
1996	Overlaid ETS/CEM data when possible	Overlaid ETS/CEM data when possible
1997	Overlaid ETS/CEM data when possible	Overlaid ETS/CEM data when possible
1998	Grew from 1997 data and overlaid ETS/CEM data when possible	Grew from 1997 data and overlaid ETS/CEM data when possible

Figure 5-1. States Submitting Point and/or Area Source Data for the 1996 PEI



🟥 Point/Area Received

▨ Point Received

□ To Be Processed FY2000

* Allegheny and Philadelphia Counties Processed

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Chapter 6.0 Biogenic Emissions

6.1 WHAT EMISSIONS DATA DOES EPA PRESENT IN THIS CHAPTER?

This chapter presents preliminary biogenic volatile organic compound (VOC) and nitric oxide (NO) emissions for 1988, 1990, 1991, 1995, 1996, and 1997. Estimates for 1998 are not available because the United States (U.S.) Environmental Protection Agency (EPA) did not have the resources to develop biogenic estimates for that year. The 1998 estimates will be included in the 1999 Trends report. Tables 6-1 and 6-2 show VOC and NO emissions, respectively. Tables 2-1, A-2, and A-3 do not contain the biogenic emission estimates because EPA only tracks anthropogenic emissions for regulatory purposes.

6.2 HOW WERE THESE EMISSIONS GENERATED?

EPA calculated the biogenic emissions for 1988, 1991, 1995, 1996, and 1997 using the Biogenic Emissions Inventory System - Version 2 (BEIS2).[1,2,3] EPA used a slightly different version of BEIS2 to generate the 1990 estimates.

6.3 WHY DO THESE EMISSIONS VARY?

Differences in climatology (i.e., temperature and cloud cover) and land use strongly affect biogenic emissions.

6.4 HOW DOES TEMPERATURE AFFECT EMISSIONS?

Annual emissions correlate very strongly with changes in annual temperature patterns. The highest emissions levels occur in the summer when temperatures rise the highest. An increase of 10°C can cause over a two-fold increase in VOC and NO emissions. Tables 6-3 and 6-4 show the seasonal allocation of VOC and NO emissions, respectively.

6.5 HOW DOES LAND USE AFFECT EMISSIONS?

Variations in land use can greatly affect spatial variation in biogenic emissions densities. In the southern United States and Missouri, large areas of oak trees show high VOC densities, while in the midwestern United States, areas of fertilized crop lands show relatively high densities of NO. Figures 6-1 and 6-2 show the spatial variation in biogenic emission densities across the United States.

6.6 WHAT IS THE UNCERTAINTY ASSOCIATED WITH THESE ESTIMATES?

These estimates have an uncertainty factor of a maximum of two. However, biogenic emissions research continues to be quite active, and EPA expects improvements in these emission estimates in the next few years.

6.7 REFERENCES

1. Birth, T., "User's Guide to the PC Version of the Biogenic Emissions Inventory System (PC-BEIS2)," EPA-600/R-95-091, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1995.
2. Geron, C., A. Guenther, and T. Pierce, "An Improved Model for Estimating Emissions of Volatile Organic Compounds from Forests in the Eastern United States," *Journal of Geophysical Research*, vol. 99, pp. 12773-12791. 1994.
3. Williams, E., A. Guenther, and F. Fehsenfeld, "An Inventory of Nitric Oxide Emissions from Soils in the United States," *Journal of Geophysical research*, vol. 97, pp. 7511-7519. 1992.

Table 6-1. Biogenic Volatile Organic Compound Emissions by State
(thousand short tons)

State	1988	1990	1991	1995	1996	1997
Alabama	1,826	2,114	1,852	1,937	1,597	1,579
Arizona	535	542	517	548	591	545
Arkansas	1,837	1,852	1,476	1,741	1,472	1,517
California	1,815	1,778	1,711	1,794	2,125	1,623
Colorado	889	748	817	826	878	786
Connecticut	81	68	74	81	63	68
Delaware	25	19	24	26	20	21
District of Columbia	1	1	1	1	0	1
Florida	1,352	1,513	1,246	1,436	1,255	1,307
Georgia	1,666	1,958	1,609	1,721	1,454	1,405
Idaho	854	810	764	706	726	726
Illinois	283	227	257	244	191	187
Indiana	237	185	227	218	165	157
Iowa	141	95	103	112	89	93
Kansas	154	140	133	118	116	119
Kentucky	677	575	648	636	496	464
Louisiana	1,291	1,403	1,043	1,367	1,125	1,187
Maine	599	567	621	622	531	453
Maryland	164	132	155	169	127	135
Massachusetts	140	107	129	140	109	119
Michigan	581	422	548	533	394	408
Minnesota	729	519	612	636	533	502
Mississippi	1,662	1,801	1,450	1,642	1,402	1,419
Missouri	1,472	1,222	1,298	1,267	1,056	1,045
Montana	912	729	781	666	716	680
Nebraska	95	79	81	78	72	77
Nevada	152	140	142	135	158	126
New Hampshire	168	147	163	171	137	286
New Jersey	130	115	124	132	103	107
New Mexico	505	533	499	531	544	440
New York	350	303	328	361	280	290
North Carolina	1,072	1,194	1,002	1,110	908	882
North Dakota	69	49	51	48	46	50
Ohio	270	211	243	259	197	183
Oklahoma	1,013	1,016	864	887	836	811
Oregon	1,066	1,118	1,002	1,114	1,087	1,075
Pennsylvania	594	510	560	642	460	473
Rhode Island	24	18	21	24	18	20
South Carolina	738	886	652	755	626	632
South Dakota	142	103	113	104	102	102
Tennessee	1,063	1,022	1,010	997	817	781
Texas	2,711	2,864	2,244	2,649	2,481	2,431
Utah	407	374	353	345	410	324
Vermont	102	91	100	106	88	90
Virginia	911	886	850	917	728	714
Washington	685	780	650	801	735	763
West Virginia	510	420	473	492	383	368
Wisconsin	648	450	516	541	412	398
Wyoming	505	387	397	358	396	223
National	**33,852**	**33,224**	**30,536**	**32,742**	**29,254**	**28,194**

NOTE: The sums of States may not equal National total due to rounding.

Table 6-2. Biogenic Nitric Oxide Emissions by State
(thousand short tons)

State	1988	1990	1991	1995	1996	1997
Alabama	14	19	14	14	14	14
Arizona	55	51	53	55	58	55
Arkansas	19	21	19	19	18	18
California	42	40	42	42	44	41
Colorado	39	35	38	38	39	35
Connecticut	1	1	1	1	1	1
Delaware	2	2	2	2	2	2
District of Columbia	0	0	0	0	0	0
Florida	22	29	22	22	22	22
Georgia	19	29	20	20	19	19
Idaho	25	23	24	24	24	24
Illinois	90	84	90	86	81	82
Indiana	49	48	51	49	46	46
Iowa	93	82	90	87	81	85
Kansas	91	87	91	85	83	85
Kentucky	19	20	20	19	18	18
Louisiana	19	20	19	19	19	19
Maine	3	3	3	3	2	2
Maryland	6	6	6	6	6	6
Massachusetts	1	1	1	1	1	1
Michigan	25	25	26	25	23	24
Minnesota	58	52	56	54	50	53
Mississippi	19	22	19	19	19	18
Missouri	44	42	44	42	40	40
Montana	60	49	57	53	52	50
Nebraska	91	83	90	86	80	85
Nevada	46	38	44	44	47	41
New Hampshire	1	1	1	1	1	2
New Jersey	2	2	2	2	2	2
New Mexico	62	59	61	64	65	56
New York	17	19	18	18	17	17
North Carolina	21	26	22	21	20	20
North Dakota	51	42	48	44	43	47
Ohio	36	36	37	35	33	33
Oklahoma	35	37	35	34	34	33
Oregon	24	22	23	23	23	23
Pennsylvania	19	21	20	20	18	19
Rhode Island	0	0	0	0	0	0
South Carolina	10	16	11	11	10	10
South Dakota	62	53	60	56	52	56
Tennessee	17	18	18	17	16	16
Texas	199	203	199	202	206	195
Utah	28	25	27	28	29	23
Vermont	2	2	2	2	2	2
Virginia	10	12	10	10	9	9
Washington	15	15	14	15	15	15
West Virginia	4	4	4	4	3	3
Wisconsin	36	34	35	35	32	33
Wyoming	39	40	36	35	35	28
National	**1,638**	**1,596**	**1,628**	**1,591**	**1,553**	**1,529**

NOTE: The sums of States may not equal National total due to rounding.

Table 6-3. Biogenic Volatile Organic Compound Seasonal Allocation, 1988 to 1996 (percentages)

Year	Winter	Spring	Summer	Autumn
1988	3	18	61	18
1990	4	17	57	22
1991	3	21	62	14
1995	3	18	59	19
1996	3	19	58	20

Table 6-4. Biogenic Nitric Oxide Seasonal Allocation, 1988 to 1996 (percentages)

Year	Winter	Spring	Summer	Autumn
1988	11	23	42	24
1990	15	21	39	25
1991	12	24	40	23
1995	12	22	41	24
1996	12	23	41	24

Figure 6-1. Density Map of NITROGEN OXIDES 1997 Biogenic Emissions by County

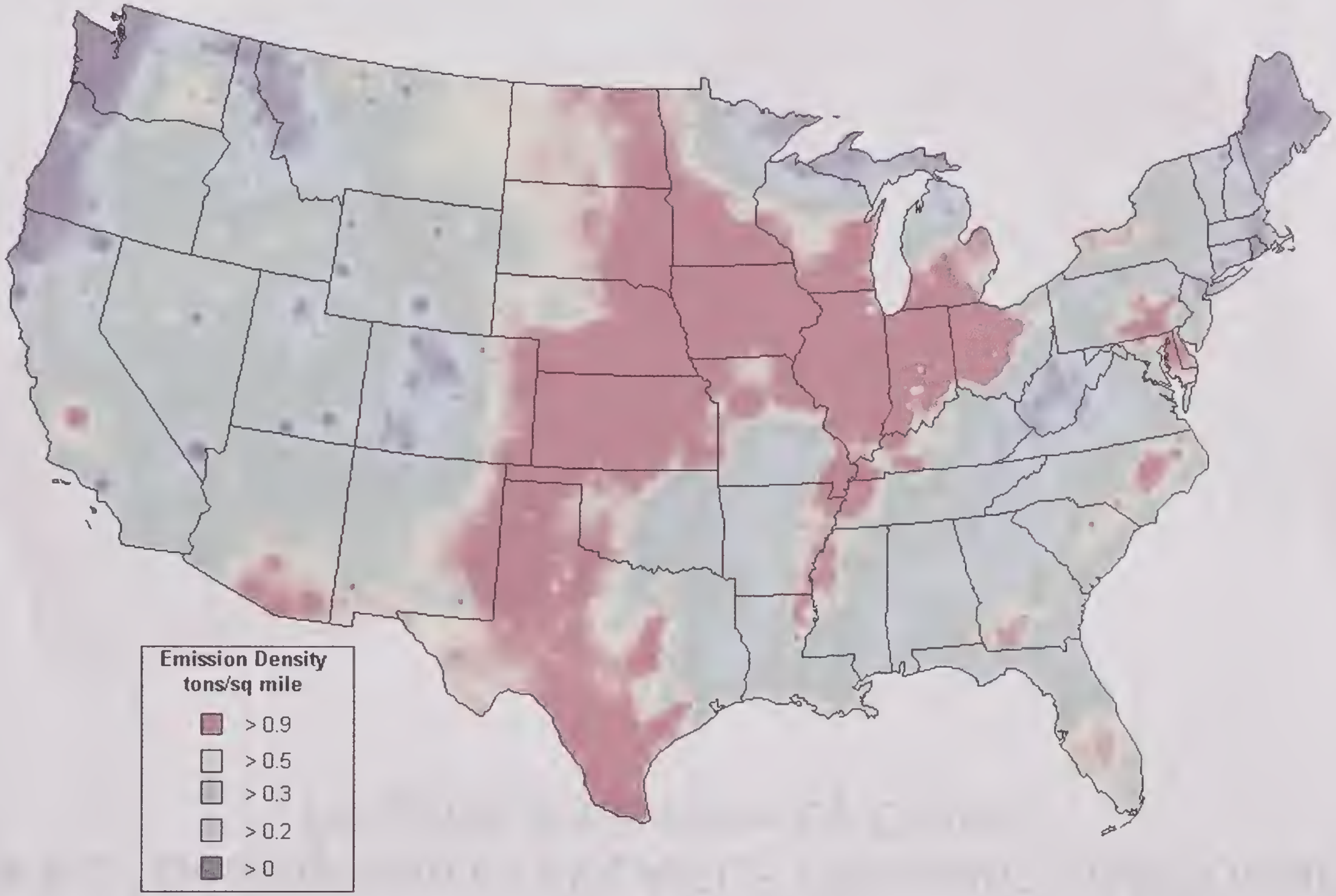
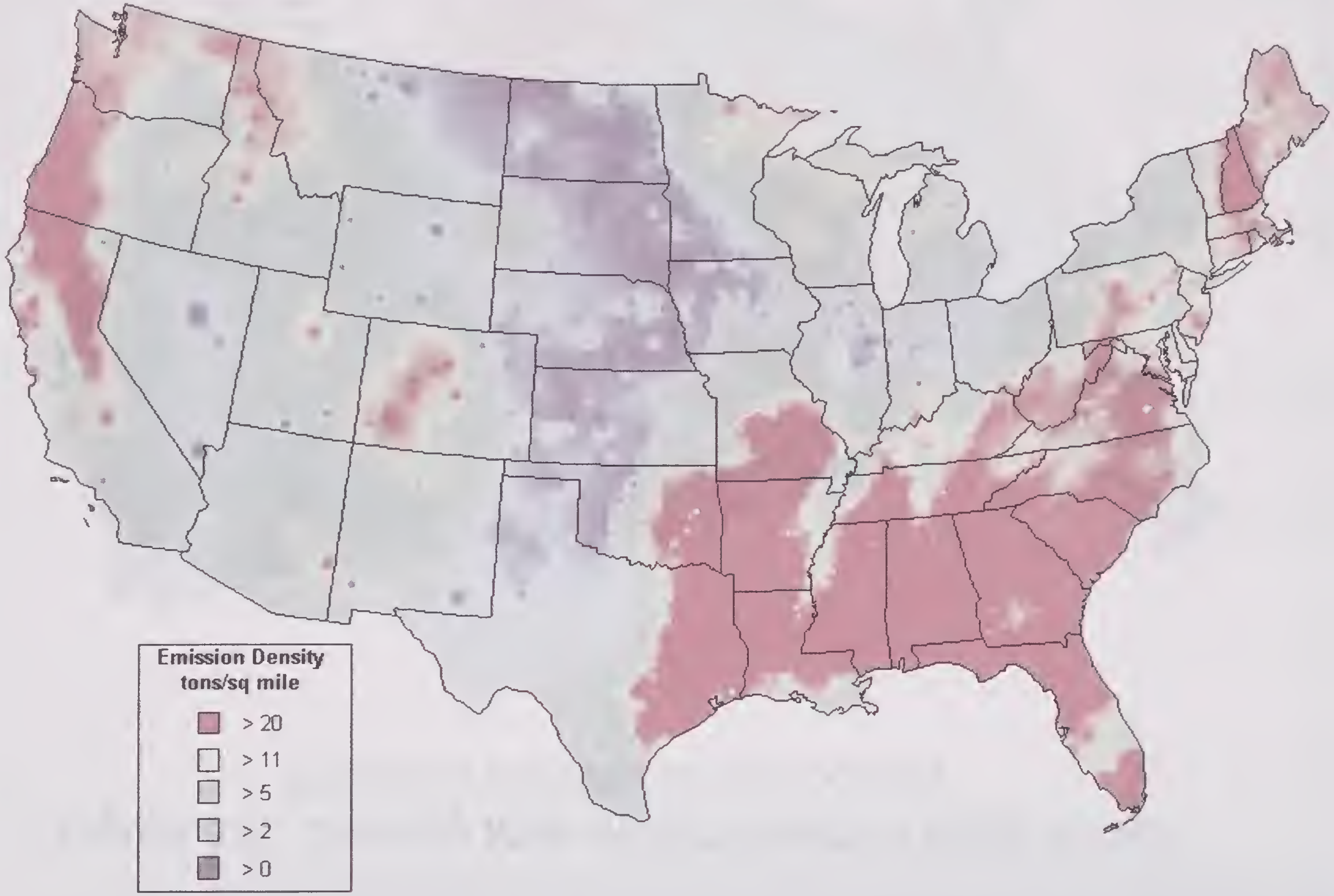

Emission Density
tons/sq mile
> 0.9
> 0.5
> 0.3
> 0.2
> 0

Figure 6-2. Density Map of VOLATILE ORGANIC COMPOUND 1997 Biogenic Emissions by County


Emission Density
tons/sq mile
🟥 > 20
☐ > 11
☐ > 5
☐ > 2
▨ > 0

Chapter 7.0 Hazardous Air Pollutants

7.1 WHAT INFORMATION IS PRESENTED IN THIS CHAPTER?

This chapter discusses hazardous air pollutants (HAPs). HAPs are commonly referred to as "air toxics" or "toxic air pollutants." They are pollutants known to cause or suspected of causing cancer or other serious human health effects or ecosystem damage. Section 112 of the Clean Air Act (CAA) now lists 188 pollutants or chemical groups as HAPs and targets stationary sources of these pollutants for regulation.[1] Examples of air toxics include heavy metals like mercury and chromium; organic chemicals like benzene, 1,3-butadiene, perchloroethylene, dioxins, and polycyclic organic matter.

HAPs are emitted from literally thousands of sources including: point sources (such as electric power utilities or industrial manufacturers), smaller area sources (such as neighborhood dry cleaners or service stations), and mobile sources (such as automobiles or airplanes). Adverse effects to human health and the environment due to HAPs can result from exposure to air toxics from individual facilities, exposure to mixtures of pollutants found in urban settings, or exposure to pollutants emitted from distant sources that are transported through the atmosphere over regional, national or even global airsheds. In addition to breathing air contaminated with air toxics, people can also be exposed to some HAPs through other pathways such as through the ingestion of contaminated food from waters polluted from the deposition of HAPs from the air to water bodies (e.g. fish contaminated with mercury).

7.2 WHAT ARE THE HEALTH AND ENVIRONMENTAL EFFECTS OF HAPs?

Most of the information on potential health effects of HAPs is derived from experimental animal data and studies of exposed workers. The different health effects which may be caused by HAPs include cancer, neurological, cardiovascular, and respiratory effects, effects on the liver, kidney, immune system, and reproductive system, and effects on fetal and child development. More than half of the 188 HAPs have been classified by the United States (U.S.) (EPA) as "known," "probable," or "possible" human carcinogens. Known human carcinogens are those that have been demonstrated to cause cancer in humans. Probable and possible human carcinogens include chemicals that we are less certain cause cancer in people, yet for which laboratory animal testing or limited human data indicates carcinogenic effects.

Some HAPs pose particular hazards to people of a certain age or stage in life (e.g., young children, adolescents, adults, or elderly people). Available data suggest that about a third of HAPs (e.g., mercury) may be developmental or reproductive toxicants in humans. This means that exposure during the development of a fetus or young child may prevent normal development into a healthy adult. Other such critical exposures may affect the ability to conceive or give birth to a healthy child. Toxic air pollutants can have a variety of environmental impacts in addition to the threats they pose to human health. Animals, like humans, may experience health problems if they breathe sufficient concentrations of HAPs over time, or ingest HAPs through contaminated food (e.g. fish).

7.3 WHY ARE AIR TOXICS INVENTORIES NEEDED?

Section 112 of the CAA added a new approach to the regulation of HAPs, consisting of two phases. The first requires the development of technology-based emissions standards for sources emitting the 188 HAPs. The second phase requires the evaluation of any remaining problems or risks, and development of additional regulations to address sources of those problems, as needed. In implementing the Section 112 provisions, EPA has collected information that helps characterize air toxics emissions. Emission inventories are a key component of this characterization process and also provide important information with which to monitor progress towards meeting the emission reduction goals.

7.3.1 Which EPA Regulatory Activities Use HAP Emission Inventories?

Phase One:

Under Section 112 of the CAA, the first phase of requirements is comprised of the technology-based standards, known as maximum achievable control technology (MACT) and generally achievable control technology (GACT) regulations. All large stationary sources, or "major" sources, of the 188 HAPs must be addressed by such regulations, as well as the smaller, "area" stationary sources found to produce significant risk or emit priority pollutants such as those identified under Section 112(c)(6) or the Integrated Urban Air Toxics Strategy described below. Some combustion sources, such as municipal waste combustors, and medical waste incinerators are regulated under equivalent requirements in Section 129. The purpose of this technology-based approach is to use available control technologies, changes in work practices, or pollution prevention methods to get emission reductions for as many of the HAPs as possible. It is expected that the MACT and GACT standards will reduce a majority of the HAP emissions and, in turn, reduce risks from regulated sources. This initial phase has generated emissions data for several industries as they are studied in the MACT and GACT regulatory development process as well as other CAA provisions that require EPA to evaluate emissions of utility industry HAP emissions, mercury, and other specific air toxics. These requirements are summarized below.

> **Utility Study, Section 112(n)(1)(A)** requires a report to Congress on the "hazards to public health reasonably anticipated to occur as a result of the emissions of electric utility steam generating units."
>
> **Mercury Study, Section 112(n)(1)(B)** requires a report to Congress regarding emissions of mercury that "shall consider the rate and mass of such emissions, the health and environmental effects of such emissions..."
>
> **Specific Pollutants, Section 112(c)(6)** requires a "list of categories and subcategories of sources assuring that sources accounting for not less that 90 percent of the aggregate emissions of each pollutant are subject to standards." This provision applies to seven specific HAPs: alkylated lead (Pb) compounds, mercury, dioxins, polycyclic organic matter (POM), hexachlorobenzene, polychlorinated biphenyls (PCBs) and furans.
>
> **Area Source Program, Section 112(c)(3)** requires that the "emissions of the 30 hazardous air pollutants that present the greatest threat to public health in the largest number of urban areas are subject to regulation."
>
> **Implementation of Section 112 through Title V of the CAA** requires the Administrator to perform an oversight role with respect to State issued permits, including permits issued to major sources of HAP emissions. In order to determine whether that program is being appropriately and lawfully administrated by the States with respect to major HAP sources, a HAP emission inventory is necessary. States are developing programs to regulate HAPs and their Title V programs must include permits for all HAP sources emitting major quantities of HAPs (10 tons of one HAP or 25 tons of multiple HAPs per year). Thus the Administrator believes maintaining an inventory of such sources is necessary and appropriate.

Phase Two:

After application of these technology-based standards and studies, in the second phase, the CAA requires strategies and programs for evaluating remaining risks and effects and ensuring that the overall program has achieved sufficient improvement. This phase will be implemented through programs that evaluate these remaining risk and effects. Such programs are described below.

> **Integrated Urban Air Toxics Strategy** responds to the requirements of Sections 112(k) and 112(c)(3) of the CAA, and also reflects activities to control mobile source emissions required under section 202(l). The goals of the Integrated Urban Air Toxics Strategy consist of the following: 1) attain a 75-percent reduction in incidence of cancer attributable to exposure to HAPs emitted by stationary sources; 2) attain a substantial reduction in public health risks posed by HAP emissions from area sources; and 3) address disproportionate impacts of air toxics hazards across urban areas. The Integrated Urban Air Toxics Strategy was finalized in July 19, 1999 *Federal Register*.[2]
>
> **Residual Risk, Section 112(f)** requires an assessment of the residual risk after certain Section 112 standards are implemented. Residual risk standards are to be developed as determined necessary eight years after promulgation of these standards.
>
> **The Great Waters Program, Section 112(m)** requires EPA to identify "the extent of atmospheric deposition of hazardous air pollutants" to specified water bodies, "evaluate any adverse effects to pubic health or the environment caused by such deposition," and determine whether additional regulations are warranted.

Inventories play a crucial role in each of these programs as the inventory information is used to evaluate current emissions, emissions reductions achieved, and identify the numerous source categories which emit specific pollutants. Inventories are an important tool in evaluating the risk reductions goals for the Integrated Urban Air Toxics Strategy. In addition, EPA is also using information from inventories to plan what future work might need to be done. For more information on Section 112 programs refer to the EPA's website at **http://www.epa.gov/ttn/uatw.html**.

7.4 WHAT IS EPA'S PLAN TO GATHER THE NECESSARY TOXICS DATA?

As the EPA began working to meet the air toxics requirements of the CAA, it became clear that there was a strong need for a central source of air toxics emissions and inventory data from which to conduct the analyses required by the CAA, and to have a place to centrally store and share the data being generated through various programs. The increased availability of air toxics emissions data will assist EPA program offices and other agencies that use emissions data to evaluate state, local, or tribal air pollution related issues. Air toxics data needs vary from national estimates of emissions to regional estimates, county-level estimates, and facility-specific estimates, and even down to process-specific estimates. Thus, in 1993, EPA began development of a national air toxics inventory data base now referred to as the National Toxics Inventory (NTI).

7.5 WHAT IS THE NTI?

The NTI is a central repository of estimated emissions for the 188 HAPs for all anthropogenic (manmade) sources.

7.5.1 How was the NTI Developed?

The national estimates of the HAPs included in the NTI to date were calculated using existing information; no source testing or industry surveys were conducted specifically for the purposes of generating the NTI. Existing emission inventory data were obtained from a variety of state and local data bases and EPA programs (such as the Toxics Release Inventory (TRI), standards development programs, and other studies required by the CAA such as the Utility Study). Sometimes emissions information is available from direct measurement of emissions at a given source. However, for logistical and financial reasons direct measurement, or stack testing, cannot be performed at every source and instead, most inventory data are developed via various estimation techniques.

Many of the national emissions estimates in the NTI (primarily for area and mobile sources) were developed by applying an emission factor, which is an emissions estimate based on test data and correlated to some other process activity. For example an emissions factor could be expressed in terms of grams emitted per ton of coal burned or per vehicle mile traveled. To estimate emissions, these factors were combined with information about the activity levels of a source, such as the production levels at the facility, the number of hours of operation, or the amount of fuel consumed.

Because there are multiple programs investigating HAP emissions in the United States, emissions data and source activity data are continually changing and improving. Since estimating emissions requires making various assumptions, the estimates are applicable for a specific time period and may not necessarily agree with other published estimates due to differences in base years, emission factors and activity data, and calculation assumptions. It should be recognized that some of the data presented in the NTI for a given base year is likely to change as more information and improved estimation approaches are developed.

EPA established a hierarchy of emissions estimation methods in order to prepare the inventory. The hierarchy is used to sort through overlapping data sources of varying quality or reliability. EPA prefers to use existing inventories that are final, and whose estimates are judged to be acceptable.

The hierarchy is (with data sources listed by preference):

1. Data developed by State and local air agencies;
2. Data from EPA's Emissions Standards Division, collected and developed for standards development;
3. Data from existing EPA inventories, such as those developed to support requirements of CAA Sections 112(k)[4] and 112(c)(6);[5] and
4. Emissions reported in the TRI data base,[6] and emissions that EPA generated using emission factors and activity factors.

If emissions data were not available for certain source categories through these references (1 - 4 above), emissions factors and activity data were used to estimate emissions. Emission factors used were evaluated for their currency, completeness, representativeness, and overall quality. The emission factors generally came from EPA's AP-42 document,[7] EPA's Locating and Estimating Document Series,[8] or the Factor Information Retrieval (FIRE) system.[9] Most of the activity data were obtained from sources such as the Energy Information Administration (fuel consumption reports), the Forest Service (fires and burned acreage), and other EPA offices (waste disposal reports). Industry trade publications, commercially published business directories, and journals were also sources of activity data.

The EPA's Office of Transportation and Air Quality (OTAQ) assisted in the development of the mobile source emissions estimates. Mobile sources include "on-road" vehicles, such as cars, trucks, and motorcycles, as well as "nonroad" vehicles and equipment, such as airplanes, boats, or lawnmowers. For many of the HAPs emitted from mobile sources, details on the emission estimation procedures are provided in the Section 112(k) inventory report.[3]

7.5.2 What are the NTI Base Years?

The Baseline NTI (1990 - 1993)
The first iteration of the NTI, referred to as the Baseline NTI, provides a composite of emissions estimates intended to represent the 1990 to 1993 time frame. Much of the baseline NTI data are for 1990, because a large portion of the national emissions data in the NTI was developed under the Section 112(c)(6) and Section 112(k) programs which targeted a 1990 base year. The TRI data and state and local data included for California, Houston, and Phoenix are for a 1993 base year. Emissions for the MACT source category portion of the NTI are annual emissions ranging from 1990 to 1993, and represent

emissions from these sources before MACT standards were implemented. The estimates in the Baseline inventory are aggregated to the county level and cover the 50 United States. The emissions summaries and graphics provided in this report are based exclusively on the Baseline NTI.

The 1996 NTI
EPA has recently completed the 1996 NTI. The 1996 version differs significantly from the Baseline NTI. Unlike the Baseline NTI which has emissions estimates from all counties by source category and pollutant, the 1996 NTI contains facility- and location-specific information making it suitable for input to computer air quality models (computer models used to for dispersion calculations which predict resultant ambient air concentrations). Methods for mobile source emissions estimates were significantly improved in the 1996 NTI also. The 1996 NTI data set contains estimates for all 50 United States and for Puerto Rico and the Virgin Islands. It has been compiled in cooperation with State and local agencies which have submitted data they have gathered during facility permitting and other regulatory activities. The 1996 NTI contains data and/or comments supplied by 46 States, Puerto Rico, and the Virgin Islands. Figure 7-1 highlights the state and local agencies that contributed data to the 1996 NTI. Subsequent base year NTIs will contain this same level of model-ready detail and will be compiled every 3 years (1999, 2002, etc.).

The 1996 NTI was completed in January 2000, but the results could not be summarized for comparison to Baseline NTI emissions in time to be printed in this document. Thus, because only one data set is summarized here, this report does not show an emissions trend over time. Instead, it provides the baseline from which trends can be measured in future reports.

7.5.3 How are Emissions Allocated to Source Types and Counties?

For purposes of the Baseline NTI, the emission estimates were further refined in two ways. First, the emissions were allocated by source type including major sources, area sources and mobile sources. Then the emissions were spatially allocated. The sections below describe these analyses.

Major/Area Source Allocation

The national emission estimates for stationary source categories were allocated according to whether the emitting source category was classified as "major," "area," or could be classified partially as both. According to Title I, Section 112(a) of the CAA, a "major source" is any stationary source (including all emission points and units located within a contiguous area and under common control) of air pollution that has the potential to emit, considering controls, 10 tons or more per year of any HAP or 25 tons or more per year of any combination of HAPs. An "area source" is any stationary source of HAPs that does not qualify as a major source. Major sources may include co-located sources which can have components that emit less that 10 tons per year of an individual HAP or 25 tons or more per year of any combination of HAP.

Spatial Allocation

Emissions were assigned to counties by a number of methods. In some cases, where actual locations were not known, emissions were assigned to individual counties using surrogate approaches. Some examples of surrogate approaches include proportioning national emissions to counties based on population, proportioning emissions from some industrial sectors to counties based on 1990 Standard Industrial Classification (SIC) code employment estimates, and assigning emissions from forest fires to counties based on forested acres.

7.5.4 What are Urban/Rural Allocations?

The emission estimates were also spatially allocated on an urban and rural basis in order to meet some of the requirements of the Integrated Urban Air Toxics Strategy. To do this, U.S. Census Bureau statistical data were used.[9] The Census Bureau has designated the portion of every county in the United States that is considered urban. The criteria used include population density and total population. Using population data and urban designations, every county in the United States was classified as one of the following categories:

- Urban-1 (U1) counties are included in a metropolitan statistical area with a population greater than 250,000;
- Urban-2 (U2) counties in which the Census Bureau designates more than 50 percent of the county population as urban; and
- Rural (R) counties in which the Census Bureau designates less than 50 percent of the county population as urban.

In the summary of 1993 NTI emissions and graphics that follow, "urban" has been designated to be the sum of U1 plus U2 counties. Figure 7-2 identifies the urban/rural counties in the 50 United States using the Integrated Urban Air Toxics Strategy definition described above. Note that these urban/rural designations have been derived exclusively for inventory purposes and do not indicate regulatory applicability.

7.5.5 What Changes Have Been Made Since the Last Trends Report?

Emission inventories are dynamic, with enhancements being made on an ongoing basis. Many revisions were made in the Baseline NTI since what was reported in the last Trends document. Public review of the compilation of the Section 112(k) Urban Air Toxics inventory and new information that became available through the MACT/GACT program led to most of these changes. Some errors in the earlier data base were also corrected. These changes led to a significant decrease in the estimates of emissions from stationary sources.

7.6 HOW ARE THE EMISSIONS SUMMARIZED?

The emissions summarized in the following pages represents the most recent version of the Baseline NTI. (This version is the "9901" version of the inventory and, as stated previously, represents a composite of emissions estimates from the 1990 to 1993 time period.) Because of the volume of data, much of the emissions information shown here involves the summary of emissions across pollutants. This cross-pollutant summary is done primarily for the sake of comparison to show the mass of all HAP emissions across source sectors (major, area, mobile), tier groups (industry sectors), populations centers (urban and rural), and geographic regions (national and state).

Any evaluation of exposure or resultant risk posed by these emissions would depend on the presence, exposure, and toxicity of individual pollutants, and cannot be surmised from the data provided here.

The sum of Baseline NTI emissions from all sources and from the 50 United States is 5.9 million tons. This version (9901) of the NTI includes emission estimates for 169 of the 188 individual and group (e.g., metal compound groups) HAPs. A list of the HAPs included is presented in Table 7-1. Approximately 580,000 tons of HAP emissions that could not be speciated into individual chemical species. These "unspeciated HAP" emissions come primarily from the synthetic organic chemicals industry MACT data. These emissions are primarily volatile organic compounds. A small subset (approximately 64 tons) of these emissions are metals and other particulate matter. It should be noted that this will Pb to the undercounting of individual HAP species from these sources, for example, benzene emissions. The Baseline NTI includes estimates for approximately 960 source categories.

7.6.1 What Individual Pollutant Detail is Given?

As part of the Integrated Urban Air Toxics Strategy, EPA identified a list of the 33 air toxics that present the greatest threat to public health in the largest number of urban areas (see Table 7-2 for list of urban air toxics). In identifying the list of "urban air toxics" pollutants EPA looked at pollutants regardless of the source sector (major, area, or mobile), from which they were emitted. Thus, EPA looked at pollutants that pose a health threat in urban areas in the aggregate, from stationary area, stationary major and mobile sources. However, the CAA requires that EPA identify at least 30 HAPs that "result from area sources." Thus, of these 33 urban air toxics, EPA identified the 30 with the greatest contribution from smaller commercial and industrial operations or so-called "area" sources. These 30 are important for establishing a list of area source categories for regulation as required by section 112(k). However, in addition to the requirement to list area source categories, the Integrated Urban Air Toxics Strategy contains the three risk reduction goals discussed earlier. It is important to remember that in looking at the risk reduction goals the Integrated Urban Air Toxics Strategy states EPA will look at the risk from all 188 HAPs, not just that associated with the 33 urban air toxics. The 33 urban air toxics represent those pollutants that are a priority on a national scale. However, on the local scale other HAPs may be play a more important role in local health risks. The emissions data that follows highlights the emissions of these 33 priority HAPs in comparison to all of the 188 HAPs. For additional background information on the Integrated Urban Air Toxics Strategy, visit EPA's website at **http://www.epa.gov/ttn/uatw/urban/urbanpg.html**.

As explained previously, because the Integrated Urban Air Toxics Strategy is designed to focus on emissions from urban areas, all emissions in the NTI are flagged accordingly to indicate whether the county from which the emissions come meets the urban definition. Figures 7-3 through Figure 7-5 indicate the percentages of national emissions totals that are from rural and urban counties and attributable to the major, area, on-road, and nonroad source sectors. Figures 7-6 and 7-7 show the summed emissions of the 188 HAPs and 33 HAPs, respectively, by state and source sector. Figures 7-8 and 7-9 present a map graphic portraying the percentiles of the summed emissions densities in tons per square mile. Figure 7-10 shows national emissions percentage of each of the 33 HAPs divided among source sectors (major, area, on-road, nonroad).

The Baseline NTI emissions are further summarized in several ways. Table 7-3 includes all 188 HAPs summed by total, urban, and rural allocations and by point, area, and mobile (on-road and nonroad) contributions. Table 7-4 repeats this information with more detail about how the point, area, and mobile sectors exist in urban and rural counties. Tables 7-5 and 7-6 indicate the summed 188 and 33 HAPs, respectively, by State and point, area, on-road, and nonroad emissions. Tables 7-7 and 7-8 summarize the 33 HAPs by source tier groups. Tiering is a method of broadly categorizing industry sectors. Tier 1 provides the most general classification (e.g., fuel combustion) with Tier 2 supplying more detail (e.g., fuel combustion by coal, oil, gas, and other fuel types). Although currently criteria pollutant and HAP emission inventories are compiled separately, and therefore the Tier groups could not be matched exactly, every effort has been made to match Tier groups as much as possible. Table 7-7 indicates Tier 1 groups and Table 7-8, Tier 1 along with Tier 2.

Within the Tier 2 groupings, emissions in the NTI are flagged according to whether they come from source categories being reviewed for MACT/GACT regulations. The MACT source emissions that are flagged in the Baseline NTI data set reflect source categories for which EPA has developed emissions estimates as part of ongoing regulatory development. Although utility emissions have a "MACT flag," no determination has been made as yet regarding whether these sources will be subject to MACT standards. Combustion sources being reviewed under section 129 are also flagged. The source categories and pollutants that are MACT flagged indicate those considered in the Integrated Urban Strategy analyses (used to determine the list of priority HAPs) prior to publication of the Strategy. That analysis resulted in an additional listing of source categories, published in the July 19, 1999 *Federal Register*.[2] These newly listed source categories do not yet have MACT flags in the NTI; once standards have been initiated to the point that emissions covered by new standards can be identified, the inventory will reflect them.

7.7 REFERENCES

1. This list originally included 189 chemicals. The CAA allows EPA to modify this list if new scientific information becomes available that indicates a change should be made. Using this authority, the Agency modified the list to remove caprolactam in 1996, reducing the list to 188 pollutants (Hazardous Air Pollutant List; Modification, 61 FR 30816, June 18, 1996).
2. "National Air Toxics Program: The Integrated Urban Strategy;" Notice, *Federal Register* 64:38705, U.S. Environmental Protection Agency. July 19, 1999.
3. "EPA Strategic Plan," EPA-190/R-97-002, Office of the Chief Financial Officer, U.S. Environmental Protection Agency, U.S. Government Printing Office, Washington, DC. 1997.
4. "1990 Emissions Inventory of Forty Potential Section 112(k) Pollutants," Supporting Data for EPA's Section 112(k) Regulatory Strategy, Final Report, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Research Triangle Park, NC. 1999.
5. "1990 Emissions Inventory of Section 112(c)(6) Pollutants: Polycyclic Organic Matter (POM), 2,3,7,8-Tetrachlorodibenzo-P-Dioxin (TCDD)/2,3,7,8-Tetrachlorodibenzofuran (TCDF), Polychlorinated Biphenyl Compounds (PCBs), Hexachlorobenzene, Mercury, and Alkylated Lead," Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1999.
6. "Toxics Release Inventory 1987-1995 CD ROM," EPA 749-C-96-003, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1996a.
7. "Compilation of Air Pollutant Emission Factors, Fifth Edition and Supplements," AP-42, Volume I: Stationary Point and Area Sources, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1996.
8. "Air Chief Compact Disc," Version 7, EPA 454/C-99-004, U.S. Environmental Protection Agency, Research Triangle Park, NC. November 1999.
9. "Factor Information Retrieval (FIRE) System Database," Version 5.1a, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1995.
10. "1990 Summary Tape File 1A, 1990 Decennial Census of Population and Housing," U.S. Census Bureau, Washington, DC. 1990.

Table 7-1. Hazardous Air Pollutants Included in the Baseline NTI (version 9901)

1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dimethylhydrazine
1,2,4-Trichlorobenzene
1,2-Dibromo-3-chloropropane
1,2-Epoxybutane
1,2-Propylenimine (2-Methylaziridine)
1,3-Butadiene
1,3-Dichloropropene
1,3-Propane sultone
1,4-Dichlorobenzene
1,4-Dioxane (1,4-Diethyleneoxide)
2,2,4-Trimethylpentane
2,3,7,8-TCDD TEQ
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,4-D (2,4-Dichlorophenoxyacetic Acid)(including salts and esters)
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,4-Toluene diisocyanate
2-Chloroacetophenone
2-Nitropropane
3,3'-Dichlorobenzidene
3,3'-Dimethoxybenzidine
3,3'-Dimethylbenzidine
4,4'-Methylenebis(2-chloroaniline)
4,4'-Methylenedianiline
4,4'-Methylenediphenyl diisocyanate (MDI)
4,6-Dinitro-o-cresol (including salts)
4-Aminobiphenyl
4-Dimethylaminoazobenzene
4-Nitrobiphenyl
4-Nitrophenol
Acetaldehyde
Acetamide
Acetonitrile
Acetophenone
Acrolein

Acrylamide
Acrylic acid
Acrylonitrile
Allyl chloride
Aniline
Antimony Compounds
Arsenic Compounds(inorganic including arsine)
Asbestos
Benzene (including benzene from gasoline)
Benzidine
Benzotrichloride
Benzyl chloride
Beryllium Compounds
Biphenyl
Bis(2-ethylhexyl)phthalate (DEHP)
Bis(chloromethyl) ether
Bromoform
Cadmium Compounds
Calcium cyanamide
Captan
Carbaryl
Carbon disulfide
Carbon tetrachloride
Carbonyl sulfide
Catechol
Chlordane
Chlorine
Chloroacetic acid
Chlorobenzene
Chlorobenzilate
Chloroform
Chloromethyl methyl ether
Chloroprene
Chromium Compounds
Cobalt Compounds
Coke Oven Emissions
Cresol/Cresylic acid (mixed isomers)
Cumene

Table 7-1 (continued)

Cyanide Compounds
Dibutyl phthalate
Dichloroethyl ether (Bis[2-chloroethyl]ether)
Dichlorvos
Diethanolamine
Diethyl sulfate
Dimethyl phthalate
Dimethyl sulfate
Epichlorohydrin (l-Chloro-2,3-epoxypropane)
Ethyl Chloride
Ethyl acrylate
Ethyl carbamate (Urethane) chloride (Chloroethane)
Ethylbenzene
Ethylene dibromide (Dibromoethane)
Ethylene dichloride (1,2-Dichloroethane)
Ethylene glycol
Ethylene oxide
Ethylene thiourea
Ethylidene dichloride (1,1-Dichloroethane)
Fine mineral fibers
Formaldehyde
Glycol ethers
Heptachlor
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Hexamethylene diisocyanate
Hexane
Hydrazine
Hydrochloric acid (Hydrogen chloride [gas only])
Hydrogen fluoride (Hydrofluoric acid)
Hydroquinone
Isophorone
Lead Compounds
Maleic anhydride
Manganese Compounds
Mercury Compounds
Methoxychlor
Methyl bromide (Bromomethane)
Methyl chloride (Chloromethane)
Methyl chloroform (1,1,1-Trichloroethane)
Methyl ethyl ketone (2-Butanone)
Methyl iodide (Iodomethane)
Methyl isobutyl ketone (Hexone)
Methyl isocyanate
Methyl methacrylate
Methyl tert-butyl ether
Methylene chloride (Dichloromethane)
Methylhydrazine
N,N-Dimethylaniline
N,N-Dimethylformamide
N-Nitrosodimethylamine
N-Nitrosomorpholine
Nickel Compounds
Nitrobenzene
Parathion
Pentachloronitrobenzene (Quintobenzene)
Pentachlorophenol
Phenol
Phosgene
Phosphine
Phosphorus Compounds
Phthalic anhydride
Polychlorinated biphenyls (Aroclors)
Polycyclic Organic Matter
Propionaldehyde
Propoxur (Baygon)
Propylene dichloride (1,2-Dichloropropane)
Propylene oxide
Quinoline
Quinone (p-Benzoquinone)
Radionuclides (including radon)
Selenium Compounds
Styrene
Styrene oxide

Table 7-1 (continued)

Methanol
Titanium tetrachloride
Toluene
Total Unspeciated HAPS
Total Unspeciated METALS
Trichloroethylene
Triethylamine
Trifluralin
Unspeciated Particulate HAPs, Chromium and Cobalt
Tetrachloroethylene (Perchloroethylene)
Vinyl acetate
Vinyl bromide
Vinyl chloride
Vinylidene chloride (1,1-Dichloroethylene)
Xylenes (mixed isomers)
o-Anisidine
o-Toluidine
p-Phenylenediamine

Table 7-2. List of Urban HAPS for the Integrated Urban Air Toxics Strategy ("Urban HAPS List")

HAP	CAS No. +	HAP	CAS No. +
acetaldehyde	75070	formaldehyde	50000
acrolein	107028	hexachlorobenzene	118741
acrylonitrile	107131	hydrazine	302012
arsenic compounds		lead compounds	
benzene	71432	manganese compounds	
beryllium compounds		mercury compounds	
1,3-butadiene	106990	methylene chloride (dichloromethane)	75092
cadmium compounds		nickel compounds	
carbon tetrachloride	56235	polychlorinated biphenyls (PCBs)	1336363
chloroform	67663	polycyclic organic matter (POM)	
chromium compounds		quinoline	91225
coke oven emissions	8007452	2,3,7,8-tetrachlorodibenzo-p-dioxin (& congeners & TCDF congeners)	1746016
1,2-dibromoethane	106934	1,1,2,2-tetrachloroethane	79345
1,2-dichloropropane (propylene dichloride)	78875	tetrachloroethylene (perchloroethylene)	127184
1,3-dichloropropene	542756	trichloroethylene	79016
ethylene dichloride (1,2-dichloroethane)	107062	vinyl chloride	75014
ethylene oxide	75218		

+ Chemical Abstracts System number.

Table 7-3. Baseline NTI Emissions for Urban, Rural, and Major Source Categories by HAP

188 HAP Name	Total National Emissions (tpy)	Total URBAN	Total RURAL	Total Point	Total Area	Mobile: Onroad	Mobile: Nonroad
1,1,2,2-Tetrachloroethane	248.56834	209.64691	38.92143	50.21984	198.34850	0.00000	0.00000
1,1,2-Trichloroethane	761.36164	511.34897	250.01267	754.41778	6.94386	0.00000	0.00000
1,1-Dimethylhydrazine	0.58484	0.57639	0.00845	0.58313	0.00170	0.00000	0.00000
1,2,4-Trichlorobenzene	5,865.94500	3,072.21190	2,793.73310	5,849.83966	16.10534	0.00000	0.00000
1,2-Dibromo-3-chloropropane	14.93700	11.17880	3.75820	14.78763	0.14937	0.00000	0.00000
1,2-Epoxybutane	38.05489	37.15589	0.89900	36.61370	1.44120	0.00000	0.00000
1,2-Propylenimine (2-Methylaziridine)	0.41950	0.40444	0.01506	0.41043	0.00907	0.00000	0.00000
1,3-Butadiene	71,523.56768	42,590.06162	28,933.50606	3,937.92968	20,040.53479	36,657.97824	10,887.12496
1,3-Dichloropropene	19,927.87000	16,652.12824	3,275.74176	30.48629	19,897.38371	0.00000	0.00000
1,3-Propane sultone	0.00072	0.00072	0.00000	0.00072	0.00000	0.00000	0.00000
1,4-Dichlorobenzene	5,225.64801	4,228.57842	997.06959	750.16231	4,475.48569	0.00000	0.00000
1,4-Dioxane (1,4-Diethyleneoxide)	855.24718	716.54579	138.70139	832.48441	22.76276	0.00000	0.00000
2,2,4-Trimethylpentane	29,627.36202	25,490.36625	4,136.99577	23,821.53979	5,803.52238	1.81653	0.48333
2,3,7,8-TCDD TEQ	0.00264	0.00221	0.00043	0.00170	0.00084	0.00009	0.00000
2,4,5-Trichlorophenol	0.52300	0.39141	0.13159	0.51777	0.00523	0.00000	0.00000
2,4,6-Trichlorophenol	0.59785	0.46601	0.13184	0.59017	0.00768	0.00000	0.00000
2,4-D (2,4-Dichlorophenoxyacetic Acid)(including salts and esters)	7,681.23909	2,503.84525	5,177.39385	0.64196	7,680.59714	0.00000	0.00000
2,4-Dinitrophenol	7.74550	7.08346	0.66204	7.72507	0.02044	0.00000	0.00000
2,4-Dinitrotoluene	3.50850	2.88957	0.61893	0.59401	2.91450	0.00000	0.00000
2,4-Toluene diisocyanate	67.40469	54.59477	12.80992	64.68525	2.71945	0.00000	0.00000
2-Chloroacetophenone	0.02800	0.02096	0.00704	0.02772	0.00028	0.00000	0.00000
2-Nitropropane	55.46246	52.15140	3.31106	54.21458	1.24787	0.00000	0.00000
3,3'-Dichlorobenzidene	0.51705	0.38807	0.12897	0.51189	0.00515	0.00000	0.00000
3,3'-Dimethoxybenzidine	0.87700	0.65634	0.22066	0.86823	0.00877	0.00000	0.00000
3,3'-Dimethylbenzidine	0.31600	0.23649	0.07951	0.31284	0.00316	0.00000	0.00000
4,4'-Methylenebis(2-chloroaniline)	0.92945	0.61097	0.31848	0.91624	0.01321	0.00000	0.00000
4,4'-Methylenedianiline	3.97348	3.61660	0.35689	3.83849	0.13500	0.00000	0.00000
4,4'-Methylenediphenyl diisocyanate (MDI)	244.24576	117.53081	126.71495	195.79506	48.45070	0.00000	0.00000
4,6-Dinitro-o-cresol (including salts)	0.58850	0.44471	0.14379	0.58262	0.00588	0.00000	0.00000
4-Aminobiphenyl	0.18200	0.13621	0.04579	0.18018	0.00182	0.00000	0.00000
4-Dimethylaminoazobenzene	0.30800	0.23051	0.07749	0.30492	0.00308	0.00000	0.00000
4-Nitrobiphenyl	0.37300	0.27915	0.09385	0.36927	0.00373	0.00000	0.00000
4-Nitrophenol	1.54100	1.17946	0.36154	1.52561	0.01539	0.00000	0.00000
Acetaldehyde	137,166.15337	78,064.33352	59,101.81986	21,337.93570	50,533.50105	27,963.87210	37,330.84452
Acetamide	0.02806	0.02425	0.00381	0.01080	0.01726	0.00000	0.00000
Acetonitrile	1,450.60505	1,241.98190	208.62315	1,393.62584	56.97922	0.00000	0.00000
Acetophenone	291.09852	229.79161	61.30691	284.07511	7.02341	0.00000	0.00000
Acrolein	62,660.26492	28,916.89707	33,743.36785	757.25478	49,632.35798	5,541.61622	6,729.03594
Acrylamide	35.44595	33.50764	1.93831	34.59024	0.85571	0.00000	0.00000
Acrylic acid	537.18231	497.56824	39.61407	523.19176	13.99055	0.00000	0.00000
Acrylonitrile	2,543.60095	2,240.67795	302.92301	2,072.52780	471.07315	0.00000	0.00000
Allyl chloride	111.88139	100.70670	11.17469	109.10577	2.77563	0.00000	0.00000
Aniline	477.45592	397.74288	79.71305	463.54493	13.91100	0.00000	0.00000
Antimony Compounds	103.37891	79.04959	24.32932	96.76993	6.60794	0.00092	0.00012
Arsenic Compounds(inorganic including arsine)	288.43199	203.83865	84.59334	230.28133	55.36306	1.74759	1.04001
Asbestos	8.50164	6.49092	2.01072	7.22413	1.27752	0.00000	0.00000
Benzene (including benzene from gasoline)	389,347.91615	258,044.08078	131,303.83537	36,440.67051	73,236.15328	207,259.79811	72,411.29424
Benzidine	0.40000	0.30137	0.09863	0.39578	0.00422	0.00000	0.00000
Benzotrichloride	10.23650	7.92716	2.30934	10.02818	0.20832	0.00000	0.00000
Benzyl chloride	33.55681	28.15413	5.40268	31.98701	1.56979	0.00000	0.00000

Table 7-3 (continued)

188 HAP Name	Total National Emissions (tpy)	Total URBAN	Total RURAL	Total Point	Total Area	Mobile: Onroad	Mobile: Nonroad
Beryllium Compounds	12.39344	8.52101	3.87243	9.75393	2.61950	0.00000	0.02000
Biphenyl	863.26496	557.22057	306.04439	832.45108	30.79378	0.01470	0.00539
Bis(2-ethylhexyl)phthalate (DEHP)	859.69315	634.86878	224.82437	814.37464	45.31851	0.00000	0.00000
Bis(chloromethyl) ether	0.43589	0.40250	0.03339	0.42541	0.01048	0.00000	0.00000
Bromoform	8.47200	6.34042	2.13158	8.38728	0.08472	0.00000	0.00000
Cadmium Compounds	199.12086	161.96437	37.15649	158.93650	39.87356	0.00068	0.31011
Calcium cyanamide	6.31000	6.31000	0.00000	3.55821	2.75179	0.00000	0.00000
Captan	2.16500	1.88151	0.28349	2.14356	0.02144	0.00000	0.00000
Carbaryl	1.91825	0.80109	1.11716	0.01337	1.90489	0.00000	0.00000
Carbon disulfide	130,279.58604	73,572.05191	56,707.53414	129,372.03640	907.54965	0.00000	0.00000
Carbon tetrachloride	5,040.51156	2,948.70650	2,091.80506	4,941.43259	99.07897	0.00000	0.00000
Carbonyl sulfide	12,244.95793	10,303.97508	1,940.98285	10,028.32515	2,216.63278	0.00000	0.00000
Catechol	12.72200	12.72108	0.00092	10.39509	2.32692	0.00000	0.00000
Chlordane	0.05100	0.04766	0.00334	0.04894	0.00206	0.00000	0.00000
Chlorine	77,392.29466	71,653.78964	5,738.50501	74,484.06927	2,908.11374	0.08699	0.02465
Chloroacetic acid	40.85950	31.16850	9.69100	39.51657	1.34293	0.00000	0.00000
Chlorobenzene	11,900.28694	8,919.49726	2,980.78968	2,827.48748	9,072.79946	0.00000	0.00000
Chlorobenzilate	2.01430	2.01430	0.00000	2.01430	0.00000	0.00000	0.00000
Chloroform	22,735.28325	13,243.25231	9,492.03094	22,158.72255	576.56070	0.00000	0.00000
Chloromethyl methyl ether	6.18450	5.73760	0.44690	6.02049	0.16401	0.00000	0.00000
Chloroprene	1,050.82941	1,014.07621	36.75320	1,039.40976	11.41966	0.00000	0.00000
Chromium Compounds	897.15022	727.40183	169.74840	573.79284	269.62666	27.93068	25.80005
Cobalt Compounds	65.69997	50.39620	15.30377	60.20699	5.49278	0.00017	0.00003
Coke Oven Emissions	1,763.69000	1,702.87310	60.81690	1,763.69000	0.00000	0.00000	0.00000
Cresol/Cresylic acid (mixed isomers)	11,327.03156	6,194.55986	5,132.47171	11,316.14891	10.88266	0.00000	0.00000
Cumene	11,418.27801	7,232.35156	4,185.92645	11,260.55879	157.71921	0.00000	0.00000
Cyanide Compounds	2,405.32835	2,279.03686	126.29149	1,318.00259	1,087.32577	0.00000	0.00000
Dibutyl phthalate	132.83833	109.90941	22.92892	126.25370	6.58464	0.00000	0.00000
Dichloroethyl ether (Bis[2-chloroethyl]ether)	7.05000	3.68018	3.36982	6.20388	0.84612	0.00000	0.00000
Dichlorvos	0.25750	0.11363	0.14387	0.25334	0.00417	0.00000	0.00000
Diethanolamine	86.25437	78.38355	7.87081	85.24043	1.01393	0.00000	0.00000
Diethyl sulfate	3.11950	2.79060	0.32890	3.04919	0.07031	0.00000	0.00000
Dimethyl phthalate	153.74479	29.25621	124.48857	147.67810	6.06669	0.00000	0.00000
Dimethyl sulfate	3.84856	2.23144	1.61712	3.31418	0.53437	0.00000	0.00000
Epichlorohydrin (l-Chloro-2,3-epoxypropane)	339.73705	301.08182	38.65523	328.80845	10.92860	0.00000	0.00000
Ethyl Chloride	2,187.89548	1,724.48321	463.41227	2,023.60286	164.29262	0.00000	0.00000
Ethyl acrylate	159.97414	151.47688	8.49726	153.58316	6.39099	0.00000	0.00000
Ethyl carbamate (Urethane) chloride (Chloroethane)	9.05249	7.73941	1.31309	8.49508	0.55742	0.00000	0.00000
Ethylbenzene	150,602.95817	108,128.60788	42,474.35029	15,993.92246	3,698.17652	93,074.62992	37,836.22926
Ethylene dibromide (Dibromoethane)	57.53988	37.63972	19.90017	53.93372	3.60617	0.00000	0.00000
Ethylene dichloride (1,2-Dichloroethane)	4,198.60429	3,018.35098	1,180.25331	4,095.94988	102.65441	0.00000	0.00000
Ethylene glycol	12,310.94365	9,807.54261	2,503.40104	11,396.21899	914.72465	0.00000	0.00000
Ethylene oxide	2,761.74987	2,340.11324	421.63663	1,423.16536	1,338.58451	0.00000	0.00000
Ethylene thiourea	1.68367	1.68367	0.00000	1.68367	0.00000	0.00000	0.00000
Ethylidene dichloride (1,1-Dichloroethane)	273.34234	227.28584	46.05650	33.16484	240.17751	0.00000	0.00000
Fine mineral fibers	0.44862	0.44862	0.00000	0.44862	0.00000	0.00000	0.00000
Formaldehyde	347,326.51381	199,513.35769	147,813.15612	30,493.37702	140,611.16651	96,816.50995	79,405.46035
Glycol ethers	68,264.06943	57,179.63996	11,084.42947	56,932.15300	11,331.91643	0.00000	0.00000
Heptachlor	0.03100	0.02897	0.00203	0.02975	0.00125	0.00000	0.00000
Hexachlorobenzene	1.58467	1.29928	0.28539	1.01845	0.56622	0.00000	0.00000
Hexachlorobutadiene	15.09100	11.08324	4.00776	14.89069	0.20031	0.00000	0.00000

Table 7-3 (continued)

188 HAP Name	Total National Emissions (tpy)	Total URBAN	Total RURAL	Total Point	Total Area	Mobile: Onroad	Mobile: Nonroad
Hexachlorocyclopentadiene	4.07400	3.32985	0.74415	3.85667	0.21734	0.00000	0.00000
Hexachloroethane	25.54000	24.54020	0.99980	6.19737	19.34263	0.00000	0.00000
Hexamethylene diisocyanate	0.13974	0.13974	0.00000	0.13974	0.00000	0.00000	0.00000
Hexane	188,727.94715	142,971.89168	45,756.05548	60,034.41637	23,237.08544	80,624.60109	24,831.84425
Hydrazine	20.46295	13.27919	7.18377	19.06044	1.40251	0.00000	0.00000
Hydrochloric acid (Hydrogen chloride [gas only])	339,677.12607	249,698.74905	89,978.37702	298,750.97695	40,926.14911	0.00000	0.00000
Hydrogen fluoride (Hydrofluoric acid)	33,883.94892	21,979.39136	11,904.55757	31,841.65853	2,042.29040	0.00000	0.00000
Hydroquinone	90.38896	68.97085	21.41811	89.44520	0.94376	0.00000	0.00000
Isophorone	402.62448	290.36651	112.25797	281.70725	120.91723	0.00000	0.00000
Lead Compounds	3,307.14259	2,738.84886	568.29373	1,690.88478	419.99999	418.01335	778.24448
Maleic anhydride	215.24860	191.48367	23.76493	212.31816	2.93044	0.00000	0.00000
Manganese Compounds	2,908.92074	2,007.63778	901.28296	2,349.91056	506.98243	21.68763	30.34011
Mercury Compounds	205.95234	163.65582	42.29652	123.36402	70.69372	4.96458	6.93002
Methanol	385,706.55818	253,285.37433	132,421.18385	294,128.87245	91,577.65111	0.00000	0.03462
Methoxychlor	0.04800	0.04800	0.00000	0.04648	0.00152	0.00000	0.00000
Methyl bromide (Bromomethane)	30,984.83370	24,978.61034	6,006.22336	3,144.75726	27,840.07644	0.00000	0.00000
Methyl chloride (Chloromethane)	6,448.11666	5,420.61004	1,027.50662	6,278.24335	169.87331	0.00000	0.00000
Methyl chloroform (1,1,1-Trichloroethane)	214,949.10156	185,432.31956	29,516.78200	137,397.75765	77,551.34391	0.00000	0.00000
Methyl ethyl ketone (2-Butanone)	207,791.18347	183,446.29278	24,344.89069	188,650.74773	19,140.23388	0.18848	0.01338
Methyl iodide (Iodomethane)	36.85000	33.98526	2.86474	35.83947	1.01053	0.00000	0.00000
Methyl isobutyl ketone (Hexone)	35,693.57825	29,212.34520	6,481.23304	31,062.51426	4,631.06400	0.00000	0.00000
Methyl isocyanate	5.48950	4.93401	0.55549	5.31432	0.17517	0.00000	0.00000
Methyl methacrylate	1,844.52803	1,502.97025	341.55778	1,662.50712	182.02091	0.00000	0.00000
Methyl tert-butyl ether	14,433.46646	10,632.91143	3,800.55502	5,258.32154	9,175.14492	0.00000	0.00000
Methylene chloride (Dichloromethane)	124,285.50179	100,615.53602	23,669.96577	87,900.64802	36,384.85376	0.00000	0.00000
Methylhydrazine	0.01300	0.01136	0.00164	0.01284	0.00016	0.00000	0.00000
N,N-Dimethylaniline	22.57050	18.95418	3.61632	3.08854	19.48195	0.00000	0.00000
N,N-Dimethylformamide	3,284.93673	3,063.75202	221.18470	3,175.27412	109.66261	0.00000	0.00000
N-Nitrosodimethylamine	19.86900	18.39534	1.47367	19.28712	0.58189	0.00000	0.00000
N-Nitrosomorpholine	0.63000	0.47149	0.15851	0.62370	0.00630	0.00000	0.00000
Nickel Compounds	1,329.52989	1,195.97140	133.55850	916.23402	318.41674	15.54908	79.33005
Nitrobenzene	48.57008	44.84957	3.72051	47.33858	1.23150	0.00000	0.00000
Parathion	0.61000	0.60750	0.00250	0.59066	0.01934	0.00000	0.00000
Pentachloronitrobenzene (Quintobenzene)	2.45669	1.73269	0.72400	2.40955	0.04715	0.00000	0.00000
Pentachlorophenol	6.20350	2.57703	3.62647	2.69357	3.50993	0.00000	0.00000
Phenol	11,514.93212	7,935.49774	3,579.43438	11,165.60703	349.32157	0.00000	0.00352
Phosgene	4.57351	3.91680	0.65671	4.43914	0.13437	0.00000	0.00000
Phosphine	3.13436	3.13436	0.00000	2.85807	0.27629	0.00000	0.00000
Phosphorus Compounds	161.98552	146.90031	15.08522	124.97520	37.01033	0.00000	0.00000
Phthalic anhydride	468.36056	425.68662	42.67394	437.88687	30.47368	0.00000	0.00000
Polychlorinated biphenyls (Aroclors)	0.04958	0.03845	0.01114	0.02430	0.02528	0.00000	0.00000
Polycyclic Organic Matter	17,535.29518	13,232.81263	4,302.48255	7,585.71388	9,839.12904	76.98431	33.46794
Propionaldehyde	14,187.80399	10,363.07906	3,824.72492	2,461.84192	6.07369	5,283.05624	6,436.83213
Propoxur (Baygon)	0.00500	0.00500	0.00000	0.00478	0.00022	0.00000	0.00000
Propylene dichloride (1,2-Dichloropropane)	654.98931	541.79724	113.19208	611.35524	43.63406	0.00000	0.00000
Propylene oxide	3,257.81786	2,939.97556	317.84229	2,923.70035	334.11751	0.00000	0.00000
Quinoline	26.02550	24.02860	1.99690	25.52454	0.50096	0.00000	0.00000
Quinone (p-Benzoquinone)	8.05050	6.99636	1.05414	7.97080	0.07970	0.00000	0.00000
Radionuclides (including radon)	7.80214	7.72292	0.07922	7.80214	0.00000	0.00000	0.00000
Selenium Compounds	355.37407	257.83442	97.53965	335.16779	19.66621	0.00006	0.54001
Styrene	56,139.36148	41,332.13409	14,807.22739	32,326.89290	3,811.43977	17,777.70916	2,223.31966
Styrene oxide	0.17600	0.17548	0.00052	0.17242	0.00359	0.00000	0.00000

Table 7-3 (continued)

188 HAP Name	Total National Emissions (tpy)	Total URBAN	Total RURAL	Total Point	Total Area	Mobile: Onroad	Mobile: Nonroad
Tetrachloroethylene (Perchloroethylene)	128,000.71200	105,308.90354	22,691.80846	22,960.63954	105,040.07247	0.00000	0.00000
Titanium tetrachloride	6.24600	5.71788	0.52812	6.12960	0.11640	0.00000	0.00000
Toluene	1,108,201.65839	792,801.42530	315,400.23308	195,867.77842	129,771.36341	631,796.16151	150,766.35504
Total Unspeciated HAPs	580,281.00000	508,817.13009	71,463.86991	575,265.21000	5,015.79000	0.00000	0.00000
Total Unspeciated METALS	64.31000	54.17513	10.13487	63.66690	0.64310	0.00000	0.00000
Trichloroethylene	71,998.64943	63,351.74653	8,646.90290	58,240.01715	13,758.63228	0.00000	0.00000
Triethylamine	443.52550	403.50053	40.02497	328.89055	114.63494	0.00000	0.00000
Trifluralin	10.15027	9.08566	1.06461	9.82151	0.32876	0.00000	0.00000
Unspeciated Particulate HAPs, Chromium and Cobalt	0.43000	0.37840	0.05160	0.31820	0.11180	0.00000	0.00000
Vinyl acetate	3,864.49624	3,281.14888	583.34736	3,730.06177	134.43448	0.00000	0.00000
Vinyl bromide	1.43700	1.32001	0.11699	1.42743	0.00958	0.00000	0.00000
Vinyl chloride	2,712.08592	2,389.81085	322.27507	2,142.66959	569.41633	0.00000	0.00000
Vinylidene chloride (1,1-Dichloroethylene)	223.89224	208.88484	15.00740	176.57818	47.31406	0.00000	0.00000
Xylenes (mixed isomers)	702,577.76064	509,581.85529	192,995.90535	130,837.39623	65,901.91643	355,204.93935	150,633.50864
o-Anisidine	0.82360	0.67164	0.15196	0.81440	0.00921	0.00000	0.00000
o-Toluidine	9.30050	8.73017	0.57033	8.72284	0.57765	0.00000	0.00000
p-Phenylenediamine	2.13950	1.84372	0.29578	2.11602	0.02348	0.00000	0.00000

Note(s): The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-4. Baseline NTI (1990 to 1993)
188 HAPS by Urban and Rural Designation and Source Sector (Point, Area, On-road, and Non-road)

		Urban (U1+U2) Emissions (tpy)					
188 HAP Name	Total Emissions (tpy)	Total URBAN	POINT	AREA	Total MOBILE	MOBILE: On-Road	MOBILE: Non-Road
1,1,2,2-Tetrachloroethane	248.56834	209.64691	44.33364	165.31327	0.00000	0.00000	0.00000
1,1,2-Trichloroethane	761.36164	511.34897	506.50926	4.83971	0.00000	0.00000	0.00000
1,1-Dimethylhydrazine	0.58484	0.57639	0.57477	0.00162	0.00000	0.00000	0.00000
1,2,4-Trichlorobenzene	5,865.94500	3,072.21190	3,062.42987	9.78203	0.00000	0.00000	0.00000
1,2-Dibromo-3-chloropropane	14.93700	11.17880	11.06701	0.11179	0.00000	0.00000	0.00000
1,2-Epoxybutane	38.05489	37.15589	35.77124	1.38466	0.00000	0.00000	0.00000
1,2-Propylenimine (2-Methylaziridine)	0.41950	0.40444	0.39552	0.00892	0.00000	0.00000	0.00000
1,3-Butadiene	71,523.56768	42,590.06162	3,608.52001	5,505.33549	33,476.20612	24,272.22230	9,203.98382
1,3-Dichloropropene	19,927.87000	16,652.12824	29.63065	16,622.49758	0.00000	0.00000	0.00000
1,3-Propane sultone	0.00072	0.00072	0.00072	0.00000	0.00000	0.00000	0.00000
1,4-Dichlorobenzene	5,225.64801	4,228.57842	480.06567	3,748.51275	0.00000	0.00000	0.00000
1,4-Dioxane (1,4-Diethyleneoxide)	855.24718	716.54579	698.59597	17.94981	0.00000	0.00000	0.00000
2,2,4-Trimethylpentane	29,627.36202	25,490.36625	21,623.70597	3,864.36043	2.29985	1.81653	0.48333
2,3,7,8-TCDD TEQ	0.00264	0.00221	0.00147	0.00068	0.00006	0.00006	0.00000
2,4,5-Trichlorophenol	0.52300	0.39141	0.38750	0.00391	0.00000	0.00000	0.00000
2,4,6-Trichlorophenol	0.59785	0.46601	0.45965	0.00636	0.00000	0.00000	0.00000
2,4-D (2,4-Dichlorophenoxyacetic Acid) (including salts and esters)	7,681.23909	2,503.84525	0.50638	2,503.33887	0.00000	0.00000	0.00000
2,4-Dinitrophenol	7.74550	7.08346	7.06763	0.01584	0.00000	0.00000	0.00000
2,4-Dinitrotoluene	3.50850	2.88957	0.45520	2.43438	0.00000	0.00000	0.00000
2,4-Toluene diisocyanate	67.40469	54.59477	52.81209	1.78268	0.00000	0.00000	0.00000
2-Chloroacetophenone	0.02800	0.02096	0.02075	0.00021	0.00000	0.00000	0.00000
2-Nitropropane	55.46246	52.15140	51.02966	1.12174	0.00000	0.00000	0.00000
3,3'-Dichlorobenzidene	0.51705	0.38807	0.38421	0.00386	0.00000	0.00000	0.00000
3,3'-Dimethoxybenzidine	0.87700	0.65634	0.64978	0.00656	0.00000	0.00000	0.00000
3,3'-Dimethylbenzidine	0.31600	0.23649	0.23413	0.00236	0.00000	0.00000	0.00000
4,4'-Methylenebis(2-chloroaniline)	0.92945	0.61097	0.60523	0.00574	0.00000	0.00000	0.00000
4,4'-Methylenedianiline	3.97348	3.61660	3.48515	0.13145	0.00000	0.00000	0.00000
4,4'-Methylenediphenyl diisocyanate (MDI)	244.24576	117.53081	93.81110	23.71971	0.00000	0.00000	0.00000
4,6-Dinitro-o-cresol (including salts)	0.58850	0.44471	0.44027	0.00444	0.00000	0.00000	0.00000
4-Aminobiphenyl	0.18200	0.13621	0.13485	0.00136	0.00000	0.00000	0.00000
4-Dimethylaminoazobenzene	0.30800	0.23051	0.22820	0.00231	0.00000	0.00000	0.00000
4-Nitrobiphenyl	0.37300	0.27915	0.27636	0.00279	0.00000	0.00000	0.00000
4-Nitrophenol	1.54100	1.17946	1.16769	0.01178	0.00000	0.00000	0.00000
Acetaldehyde	137,166.15337	78,064.33352	13,784.58594	14,311.14936	49,968.59822	18,515.76338	31,452.83484
Acetamide	0.02806	0.02425	0.00983	0.01442	0.00000	0.00000	0.00000
Acetonitrile	1,450.60505	1,241.98190	1,192.97265	49.00925	0.00000	0.00000	0.00000
Acetophenone	291.09852	229.79161	223.45004	6.34157	0.00000	0.00000	0.00000
Acrolein	62,660.26492	28,916.89707	602.87233	18,900.59786	9,413.42688	3,669.25674	5,744.17014
Acrylamide	35.44595	33.50764	32.70125	0.80639	0.00000	0.00000	0.00000
Acrylic acid	537.18231	497.56824	484.64749	12.92076	0.00000	0.00000	0.00000
Acrylonitrile	2,543.60095	2,240.67795	1,834.51554	406.16240	0.00000	0.00000	0.00000
Allyl chloride	111.88139	100.70670	98.24759	2.45912	0.00000	0.00000	0.00000
Aniline	477.45592	397.74288	386.58855	11.15433	0.00000	0.00000	0.00000
Antimony Compounds	103.37891	79.04959	73.86863	5.17992	0.00104	0.00092	0.00012
Arsenic Compounds(inorganic including arsine)	288.43199	203.83865	171.26981	30.55316	2.01568	1.15715	0.85853
Asbestos	8.50164	6.49092	5.72894	0.76198	0.00000	0.00000	0.00000

Table 7-4 (continued)

		Urban (U1+U2) Emissions (tpy)					
188 HAP Name	Total Emissions (tpy)	Total URBAN	POINT	AREA	Total MOBILE	MOBILE: On-Road	MOBILE: Non-Road
Benzene (including benzene from gasoline)	389,347.91615	258,044.08078	31,478.71629	28,699.07455	197,866.28994	137,232.63757	60,633.65237
Benzidine	0.40000	0.30137	0.29814	0.00323	0.00000	0.00000	0.00000
Benzotrichloride	10.23650	7.92716	7.76807	0.15909	0.00000	0.00000	0.00000
Benzyl chloride	33.55681	28.15413	26.96487	1.18925	0.00000	0.00000	0.00000
Beryllium Compounds	12.39344	8.52101	6.27767	2.22682	0.01651	0.00000	0.01651
Biphenyl	863.26496	557.22057	542.28797	14.91250	0.02010	0.01470	0.00539
Bis(2-ethylhexyl)phthalate (DEHP)	859.69315	634.86878	600.25010	34.61868	0.00000	0.00000	0.00000
Bis(chloromethyl) ether	0.43589	0.40250	0.39235	0.01015	0.00000	0.00000	0.00000
Bromoform	8.47200	6.34042	6.27701	0.06340	0.00000	0.00000	0.00000
Cadmium Compounds	199.12086	161.96437	128.85511	32.85255	0.25670	0.00068	0.25602
Calcium cyanamide	6.31000	6.31000	3.55821	2.75179	0.00000	0.00000	0.00000
Captan	2.16500	1.88151	1.86288	0.01863	0.00000	0.00000	0.00000
Carbaryl	1.91825	0.80109	0.01162	0.78948	0.00000	0.00000	0.00000
Carbon disulfide	130,279.58604	73,572.05191	72,783.21274	788.83917	0.00000	0.00000	0.00000
Carbon tetrachloride	5,040.51156	2,948.70650	2,865.86375	82.84275	0.00000	0.00000	0.00000
Carbonyl sulfide	12,244.95793	10,303.97508	8,547.65521	1,756.31987	0.00000	0.00000	0.00000
Catechol	12.72200	12.72108	10.39418	2.32691	0.00000	0.00000	0.00000
Chlordane	0.05100	0.04766	0.04563	0.00203	0.00000	0.00000	0.00000
Chlorine	77,392.29466	71,653.78964	69,139.00077	2,514.67723	0.11164	0.08699	0.02465
Chloroacetic acid	40.85950	31.16850	30.26007	0.90843	0.00000	0.00000	0.00000
Chlorobenzene	11,900.28694	8,919.49726	1,378.18167	7,541.31559	0.00000	0.00000	0.00000
Chlorobenzilate	2.01430	2.01430	2.01430	0.00000	0.00000	0.00000	0.00000
Chloroform	22,735.28325	13,243.25231	12,767.56836	475.68395	0.00000	0.00000	0.00000
Chloromethyl methyl ether	6.18450	5.73760	5.58114	0.15646	0.00000	0.00000	0.00000
Chloroprene	1,050.82941	1,014.07621	1,003.25388	10.82233	0.00000	0.00000	0.00000
Chromium Compounds	897.15022	727.40183	457.83085	229.53022	40.04075	18.49374	21.54702
Cobalt Compounds	65.69997	50.39620	45.86676	4.52924	0.00020	0.00017	0.00003
Coke Oven Emissions	1,763.69000	1,702.87310	1,702.87310	0.00000	0.00000	0.00000	0.00000
Cresol/Cresylic acid (mixed isomers)	11,327.03156	6,194.55986	6,184.60431	9.95555	0.00000	0.00000	0.00000
Cumene	11,418.27801	7,232.35156	7,107.77751	124.57404	0.00000	0.00000	0.00000
Cyanide Compounds	2,405.32835	2,279.03686	1,194.96817	1,084.06869	0.00000	0.00000	0.00000
Dibutyl phthalate	132.83833	109.90941	104.84784	5.06157	0.00000	0.00000	0.00000
Dichloroethyl ether (Bis[2-chloroethyl]ether)	7.05000	3.68018	3.25543	0.42475	0.00000	0.00000	0.00000
Dichlorvos	0.25750	0.11363	0.11245	0.00119	0.00000	0.00000	0.00000
Diethanolamine	86.25437	78.38355	77.43954	0.94401	0.00000	0.00000	0.00000
Diethyl sulfate	3.11950	2.79060	2.72365	0.06695	0.00000	0.00000	0.00000
Dimethyl phthalate	153.74479	29.25621	25.11576	4.14045	0.00000	0.00000	0.00000
Dimethyl sulfate	3.84856	2.23144	2.07993	0.15151	0.00000	0.00000	0.00000
Epichlorohydrin (l-Chloro-2,3-epoxypropane)	339.73705	301.08182	291.06777	10.01405	0.00000	0.00000	0.00000
Ethyl Chloride	2,187.89548	1,724.48321	1,603.93568	120.54753	0.00000	0.00000	0.00000
Ethyl acrylate	159.97414	151.47688	145.70058	5.77631	0.00000	0.00000	0.00000
Ethyl carbamate (Urethane) chloride (Chloroethane)	9.05249	7.73941	7.28704	0.45237	0.00000	0.00000	0.00000
Ethylbenzene	150,602.95817	108,128.60788	11,925.90343	2,948.60218	93,254.10227	61,627.41776	31,626.68451
Ethylene dibromide (Dibromoethane)	57.53988	37.63972	34.72217	2.91755	0.00000	0.00000	0.00000
Ethylene dichloride (1,2-Dichloroethane)	4,198.60429	3,018.35098	2,935.91438	82.43660	0.00000	0.00000	0.00000
Ethylene glycol	12,310.94365	9,807.54261	9,054.23043	753.31217	0.00000	0.00000	0.00000
Ethylene oxide	2,761.74987	2,340.11324	1,214.83105	1,125.28219	0.00000	0.00000	0.00000

Table 7-4 (continued)

188 HAP Name	Total Emissions (tpy)	Urban (U1+U2) Emissions (tpy)					
		Total URBAN	POINT	AREA	Total MOBILE	MOBILE: On-Road	MOBILE: Non-Road
Ethylene thiourea	1.68367	1.68367	1.68367	0.00000	0.00000	0.00000	0.00000
Ethylidene dichloride (1,1-Dichloroethane)	273.34234	227.28584	27.06962	200.21622	0.00000	0.00000	0.00000
Fine mineral fibers	0.44862	0.44862	0.44862	0.00000	0.00000	0.00000	0.00000
Formaldehyde	347,326.51381	199,513.35769	22,742.15468	45,464.09014	131,307.11287	64,105.41152	67,201.70136
Glycol ethers	68,264.06943	57,179.63996	47,775.17147	9,404.46849	0.00000	0.00000	0.00000
Heptachlor	0.03100	0.02897	0.02774	0.00123	0.00000	0.00000	0.00000
Hexachlorobenzene	1.58467	1.29928	0.88776	0.41152	0.00000	0.00000	0.00000
Hexachlorobutadiene	15.09100	11.08324	10.93131	0.15193	0.00000	0.00000	0.00000
Hexachlorocyclopentadiene	4.07400	3.32985	3.19730	0.13256	0.00000	0.00000	0.00000
Hexachloroethane	25.54000	24.54020	5.25519	19.28501	0.00000	0.00000	0.00000
Hexamethylene diisocyanate	0.13974	0.13974	0.13974	0.00000	0.00000	0.00000	0.00000
Hexane	188,727.94715	142,971.89168	51,380.70857	17,464.30677	74,126.87633	53,384.78318	20,742.09315
Hydrazine	20.46295	13.27919	12.67403	0.60516	0.00000	0.00000	0.00000
Hydrochloric acid (Hydrogen chloride [gas only])	339,677.12607	249,698.74905	214,323.46626	35,375.28279	0.00000	0.00000	0.00000
Hydrogen fluoride (Hydrofluoric acid)	33,883.94892	21,979.39136	20,545.94986	1,433.44150	0.00000	0.00000	0.00000
Hydroquinone	90.38896	68.97085	68.24125	0.72960	0.00000	0.00000	0.00000
Isophorone	402.62448	290.36651	189.34483	101.02168	0.00000	0.00000	0.00000
Lead Compounds	3,307.14259	2,738.84886	1,375.86698	353.35750	1,009.62438	276.77789	732.84649
Maleic anhydride	215.24860	191.48367	188.84454	2.63913	0.00000	0.00000	0.00000
Manganese Compounds	2,908.92074	2,007.63778	1,576.48735	391.46620	39.68422	14.36083	25.32339
Mercury Compounds	205.95234	163.65582	94.13728	60.44284	9.07570	3.28720	5.78850
Methanol	385,706.55818	253,285.37433	178,080.03925	75,205.30046	0.03462	0.00000	0.03462
Methoxychlor	0.04800	0.04800	0.04648	0.00152	0.00000	0.00000	0.00000
Methyl bromide (Bromomethane)	30,984.83370	24,978.61034	1,742.82637	23,235.78397	0.00000	0.00000	0.00000
Methyl chloride (Chloromethane)	6,448.11666	5,420.61004	5,276.90685	143.70319	0.00000	0.00000	0.00000
Methyl chloroform (1,1,1-Trichloroethane)	214,949.10156	185,432.31956	120,009.49179	65,422.82777	0.00000	0.00000	0.00000
Methyl ethyl ketone (2-Butanone)	207,791.18347	183,446.29278	167,350.92145	16,095.16947	0.20186	0.18848	0.01338
Methyl iodide (Iodomethane)	36.85000	33.98526	33.10483	0.88043	0.00000	0.00000	0.00000
Methyl isobutyl ketone (Hexone)	35,693.57825	29,212.34520	25,470.12833	3,742.21688	0.00000	0.00000	0.00000
Methyl isocyanate	5.48950	4.93401	4.76831	0.16570	0.00000	0.00000	0.00000
Methyl methacrylate	1,844.52803	1,502.97025	1,352.70287	150.26738	0.00000	0.00000	0.00000
Methyl tert-butyl ether	14,433.46646	10,632.91143	4,732.01411	5,900.89733	0.00000	0.00000	0.00000
Methylene chloride (Dichloromethane)	124,285.50179	100,615.53602	77,763.81818	22,851.71784	0.00000	0.00000	0.00000
Methylhydrazine	0.01300	0.01136	0.01122	0.00014	0.00000	0.00000	0.00000
N,N-Dimethylaniline	22.57050	18.95418	2.67727	16.27690	0.00000	0.00000	0.00000
N,N-Dimethylformamide	3,284.93673	3,063.75202	2,961.41867	102.33336	0.00000	0.00000	0.00000
N-Nitrosodimethylamine	19.86900	18.39534	17.85409	0.54125	0.00000	0.00000	0.00000
N-Nitrosomorpholine	0.63000	0.47149	0.46677	0.00471	0.00000	0.00000	0.00000
Nickel Compounds	1,329.52989	1,195.97140	828.33228	291.72860	75.91051	10.29552	65.61499
Nitrobenzene	48.57008	44.84957	43.71915	1.13042	0.00000	0.00000	0.00000
Parathion	0.61000	0.60750	0.58824	0.01926	0.00000	0.00000	0.00000
Pentachloronitrobenzene (Quintobenzene)	2.45669	1.73269	1.70098	0.03172	0.00000	0.00000	0.00000
Pentachlorophenol	6.20350	2.57703	1.50718	1.06985	0.00000	0.00000	0.00000
Phenol	11,514.93212	7,935.49774	7,669.30455	266.18967	0.00352	0.00000	0.00352
Phosgene	4.57351	3.91680	3.80795	0.10885	0.00000	0.00000	0.00000
Phosphine	3.13436	3.13436	2.85807	0.27629	0.00000	0.00000	0.00000
Phosphorus Compounds	161.98552	146.90031	113.58462	33.31569	0.00000	0.00000	0.00000

Table 7-4 (continued)

188 HAP Name	Total Emissions (tpy)	Urban (U1+U2) Emissions (tpy) Total URBAN	POINT	AREA	Total MOBILE	MOBILE: On-Road	MOBILE: Non-Road
Phthalic anhydride	468.36056	425.68662	400.25739	25.42922	0.00000	0.00000	0.00000
Polychlorinated biphenyls (Aroclors)	0.04958	0.03845	0.01779	0.02065	0.00000	0.00000	0.00000
Polycyclic Organic Matter	17,535.29518	13,232.81263	6,437.01690	6,715.67805	80.11768	51.51161	28.60606
Propionaldehyde	14,187.80399	10,363.07906	1,437.47115	5.35368	8,920.25423	3,498.05810	5,422.19613
Propoxur (Baygon)	0.00500	0.00500	0.00478	0.00022	0.00000	0.00000	0.00000
Propylene dichloride (1,2-Dichloropropane)	654.98931	541.79724	503.05067	38.74656	0.00000	0.00000	0.00000
Propylene oxide	3,257.81786	2,939.97556	2,633.35279	306.62277	0.00000	0.00000	0.00000
Quinoline	26.02550	24.02860	23.60395	0.42465	0.00000	0.00000	0.00000
Quinone (p-Benzoquinone)	8.05050	6.99636	6.92709	0.06926	0.00000	0.00000	0.00000
Radionuclides (including radon)	7.80214	7.72292	7.72292	0.00000	0.00000	0.00000	0.00000
Selenium Compounds	355.37407	257.83442	241.35026	16.03832	0.44585	0.00006	0.44578
Styrene	56,139.36148	41,332.13409	24,795.36012	2,886.49054	13,650.28344	11,771.21670	1,879.06674
Styrene oxide	0.17600	0.17548	0.17190	0.00358	0.00000	0.00000	0.00000
Tetrachloroethylene (Perchloroethylene)	128,000.71200	105,308.90354	20,600.63841	84,708.26514	0.00000	0.00000	0.00000
Titanium tetrachloride	6.24600	5.71788	5.60694	0.11093	0.00000	0.00000	0.00000
Toluene	1,108,201.65839	792,801.42530	161,051.20601	87,363.08919	544,387.13010	418,330.57430	126,056.55580
Total Unspeciated HAPs	580,281.00000	508,817.13009	504,495.12844	4,322.00165	0.00000	0.00000	0.00000
Total Unspeciated METALS	64.31000	54.17513	53.63338	0.54175	0.00000	0.00000	0.00000
Trichloroethylene	71,998.64943	63,351.74653	51,322.24782	12,029.49871	0.00000	0.00000	0.00000
Triethylamine	443.52550	403.50053	306.74315	96.75737	0.00000	0.00000	0.00000
Trifluralin	10.15027	9.08566	8.78653	0.29913	0.00000	0.00000	0.00000
Unspeciated Particulate HAPs, Chromium and Cobalt	0.43000	0.37840	0.28002	0.09838	0.00000	0.00000	0.00000
Vinyl acetate	3,864.49624	3,281.14888	3,167.48735	113.66154	0.00000	0.00000	0.00000
Vinyl bromide	1.43700	1.32001	1.31169	0.00833	0.00000	0.00000	0.00000
Vinyl chloride	2,712.08592	2,389.81085	1,908.33131	481.47954	0.00000	0.00000	0.00000
Vinylidene chloride (1,1-Dichloroethylene)	223.89224	208.88484	169.26497	39.61987	0.00000	0.00000	0.00000
Xylenes (mixed isomers)	702,577.76064	509,581.85529	102,875.68299	45,608.90358	361,097.26872	235,191.52059	125,905.74814
o-Anisidine	0.82360	0.67164	0.66396	0.00769	0.00000	0.00000	0.00000
o-Toluidine	9.30050	8.73017	8.19512	0.53504	0.00000	0.00000	0.00000
p-Phenylenediamine	2.13950	1.84372	1.82318	0.02054	0.00000	0.00000	0.00000

Note: EPA uses a data base to store these emissions. Since the data base stores very large and very small amounts, the number of decimal places displayed are an artifact of that storage and are not intended to suggest true precision of large values.

Table 7-4 (continued)

		Rural Emissions (tpy)					
188 HAP Name	Total Emissions (tpy)	Total RURAL	POINT	AREA	Total MOBILE	MOBILE: On-Road	MOBILE: Non-Road
1,1,2,2-Tetrachloroethane	248.56834	38.92143	5.88620	33.03523	0.00000	0.00000	0.00000
1,1,2-Trichloroethane	761.36164	250.01267	247.90852	2.10415	0.00000	0.00000	0.00000
1,1-Dimethylhydrazine	0.58484	0.00845	0.00836	0.00008	0.00000	0.00000	0.00000
1,2,4-Trichlorobenzene	5,865.94500	2,793.73310	2,787.40979	6.32331	0.00000	0.00000	0.00000
1,2-Dibromo-3-chloropropane	14.93700	3.75820	3.72062	0.03758	0.00000	0.00000	0.00000
1,2-Epoxybutane	38.05489	0.89900	0.84246	0.05654	0.00000	0.00000	0.00000
1,2-Propylenimine (2-Methylaziridine)	0.41950	0.01506	0.01491	0.00015	0.00000	0.00000	0.00000
1,3-Butadiene	71,523.56768	28,933.50606	329.40967	14,535.19930	14,068.89709	12,385.75594	1,683.14114
1,3-Dichloropropene	19,927.87000	3,275.74176	0.85564	3,274.88613	0.00000	0.00000	0.00000
1,3-Propane sultone	0.00072	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1,4-Dichlorobenzene	5,225.64801	997.06959	270.09664	726.97294	0.00000	0.00000	0.00000
1,4-Dioxane (1,4-Diethyleneoxide)	855.24718	138.70139	133.88844	4.81295	0.00000	0.00000	0.00000
2,2,4-Trimethylpentane	29,627.36202	4,136.99577	2,197.83382	1,939.16195	0.00000	0.00000	0.00000
2,3,7,8-TCDD TEQ	0.00264	0.00043	0.00023	0.00016	0.00003	0.00003	0.00000
2,4,5-Trichlorophenol	0.52300	0.13159	0.13027	0.00132	0.00000	0.00000	0.00000
2,4,6-Trichlorophenol	0.59785	0.13184	0.13052	0.00132	0.00000	0.00000	0.00000
2,4-D (2,4-Dichlorophenoxyacetic Acid)(including salts and esters)	7,681.23909	5,177.39385	0.13558	5,177.25827	0.00000	0.00000	0.00000
2,4-Dinitrophenol	7.74550	0.66204	0.65744	0.00460	0.00000	0.00000	0.00000
2,4-Dinitrotoluene	3.50850	0.61893	0.13881	0.48012	0.00000	0.00000	0.00000
2,4-Toluene diisocyanate	67.40469	12.80992	11.87316	0.93677	0.00000	0.00000	0.00000
2-Chloroacetophenone	0.02800	0.00704	0.00697	0.00007	0.00000	0.00000	0.00000
2-Nitropropane	55.46246	3.31106	3.18492	0.12613	0.00000	0.00000	0.00000
3,3'-Dichlorobenzidene	0.51705	0.12897	0.12768	0.00129	0.00000	0.00000	0.00000
3,3'-Dimethoxybenzidine	0.87700	0.22066	0.21845	0.00221	0.00000	0.00000	0.00000
3,3'-Dimethylbenzidine	0.31600	0.07951	0.07871	0.00080	0.00000	0.00000	0.00000
4,4'-Methylenebis(2-chloroaniline)	0.92945	0.31848	0.31101	0.00747	0.00000	0.00000	0.00000
4,4'-Methylenedianiline	3.97348	0.35689	0.35334	0.00355	0.00000	0.00000	0.00000
4,4'-Methylenediphenyl diisocyanate (MDI)	244.24576	126.71495	101.98396	24.73099	0.00000	0.00000	0.00000
4,6-Dinitro-o-cresol (including salts)	0.58850	0.14379	0.14235	0.00144	0.00000	0.00000	0.00000
4-Aminobiphenyl	0.18200	0.04579	0.04533	0.00046	0.00000	0.00000	0.00000
4-Dimethylaminoazobenzene	0.30800	0.07749	0.07672	0.00077	0.00000	0.00000	0.00000
4-Nitrobiphenyl	0.37300	0.09385	0.09291	0.00094	0.00000	0.00000	0.00000
4-Nitrophenol	1.54100	0.36154	0.35792	0.00361	0.00000	0.00000	0.00000
Acetaldehyde	137,166.15337	59,101.81986	7,553.34976	36,222.35169	15,326.11840	9,448.10872	5,878.00968
Acetamide	0.02806	0.00381	0.00097	0.00284	0.00000	0.00000	0.00000
Acetonitrile	1,450.60505	208.62315	200.65319	7.96997	0.00000	0.00000	0.00000
Acetophenone	291.09852	61.30691	60.62507	0.68184	0.00000	0.00000	0.00000
Acrolein	62,660.26492	33,743.36785	154.38245	30,731.76012	2,857.22529	1,872.35948	984.86580
Acrylamide	35.44595	1.93831	1.88899	0.04932	0.00000	0.00000	0.00000
Acrylic acid	537.18231	39.61407	38.54427	1.06979	0.00000	0.00000	0.00000
Acrylonitrile	2,543.60095	302.92301	238.01226	64.91075	0.00000	0.00000	0.00000
Allyl chloride	111.88139	11.17469	10.85818	0.31651	0.00000	0.00000	0.00000
Aniline	477.45592	79.71305	76.95638	2.75667	0.00000	0.00000	0.00000
Antimony Compounds	103.37891	24.32932	22.90130	1.42802	0.00000	0.00000	0.00000
Arsenic Compounds(inorganic including arsine)	288.43199	84.59334	59.01152	24.80990	0.77191	0.59044	0.18148
Asbestos	8.50164	2.01072	1.49519	0.51554	0.00000	0.00000	0.00000
Benzene (including benzene from gasoline)	389,347.91615	131,303.83537	4,961.95422	44,537.07873	81,804.80241	70,027.16054	11,777.64187

Table 7-4 (continued)

		Rural Emissions (tpy)					
188 HAP Name	Total Emissions (tpy)	Total RURAL	POINT	AREA	Total MOBILE	MOBILE: On-Road	MOBILE: Non-Road
Benzidine	0.40000	0.09863	0.09764	0.00099	0.00000	0.00000	0.00000
Benzotrichloride	10.23650	2.30934	2.26011	0.04923	0.00000	0.00000	0.00000
Benzyl chloride	33.55681	5.40268	5.02214	0.38054	0.00000	0.00000	0.00000
Beryllium Compounds	12.39344	3.87243	3.47626	0.39268	0.00349	0.00000	0.00349
Biphenyl	863.26496	306.04439	290.16311	15.88128	0.00000	0.00000	0.00000
Bis(2-ethylhexyl)phthalate (DEHP)	859.69315	224.82437	214.12454	10.69983	0.00000	0.00000	0.00000
Bis(chloromethyl) ether	0.43589	0.03339	0.03306	0.00033	0.00000	0.00000	0.00000
Bromoform	8.47200	2.13158	2.11027	0.02132	0.00000	0.00000	0.00000
Cadmium Compounds	199.12086	37.15649	30.08139	7.02101	0.05409	0.00000	0.05409
Calcium cyanamide	6.31000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Captan	2.16500	0.28349	0.28068	0.00281	0.00000	0.00000	0.00000
Carbaryl	1.91825	1.11716	0.00175	1.11541	0.00000	0.00000	0.00000
Carbon disulfide	130,279.58604	56,707.53414	56,588.82366	118.71048	0.00000	0.00000	0.00000
Carbon tetrachloride	5,040.51156	2,091.80506	2,075.56884	16.23622	0.00000	0.00000	0.00000
Carbonyl sulfide	12,244.95793	1,940.98285	1,480.66994	460.31291	0.00000	0.00000	0.00000
Catechol	12.72200	0.00092	0.00091	0.00001	0.00000	0.00000	0.00000
Chlordane	0.05100	0.00334	0.00331	0.00003	0.00000	0.00000	0.00000
Chlorine	77,392.29466	5,738.50501	5,345.06850	393.43651	0.00000	0.00000	0.00000
Chloroacetic acid	40.85950	9.69100	9.25650	0.43450	0.00000	0.00000	0.00000
Chlorobenzene	11,900.28694	2,980.78968	1,449.30581	1,531.48387	0.00000	0.00000	0.00000
Chlorobenzilate	2.01430	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Chloroform	22,735.28325	9,492.03094	9,391.15419	100.87675	0.00000	0.00000	0.00000
Chloromethyl methyl ether	6.18450	0.44690	0.43935	0.00755	0.00000	0.00000	0.00000
Chloroprene	1,050.82941	36.75320	36.15588	0.59733	0.00000	0.00000	0.00000
Chromium Compounds	897.15022	169.74840	115.96199	40.09644	13.68997	9.43694	4.25303
Cobalt Compounds	65.69997	15.30377	14.34023	0.96354	0.00000	0.00000	0.00000
Coke Oven Emissions	1,763.69000	60.81690	60.81690	0.00000	0.00000	0.00000	0.00000
Cresol/Cresylic acid (mixed isomers)	11,327.03156	5,132.47171	5,131.54460	0.92711	0.00000	0.00000	0.00000
Cumene	11,418.27801	4,185.92645	4,152.78128	33.14517	0.00000	0.00000	0.00000
Cyanide Compounds	2,405.32835	126.29149	123.03442	3.25708	0.00000	0.00000	0.00000
Dibutyl phthalate	132.83833	22.92892	21.40586	1.52307	0.00000	0.00000	0.00000
Dichloroethyl ether (Bis[2-chloroethyl]ether)	7.05000	3.36982	2.94845	0.42137	0.00000	0.00000	0.00000
Dichlorvos	0.25750	0.14387	0.14089	0.00298	0.00000	0.00000	0.00000
Diethanolamine	86.25437	7.87081	7.80089	0.06992	0.00000	0.00000	0.00000
Diethyl sulfate	3.11950	0.32890	0.32554	0.00336	0.00000	0.00000	0.00000
Dimethyl phthalate	153.74479	124.48857	122.56234	1.92624	0.00000	0.00000	0.00000
Dimethyl sulfate	3.84856	1.61712	1.23425	0.38286	0.00000	0.00000	0.00000
Epichlorohydrin (l-Chloro-2,3-epoxypropane)	339.73705	38.65523	37.74068	0.91455	0.00000	0.00000	0.00000
Ethyl Chloride	2,187.89548	463.41227	419.66718	43.74509	0.00000	0.00000	0.00000
Ethyl acrylate	159.97414	8.49726	7.88258	0.61468	0.00000	0.00000	0.00000
Ethyl carbamate (Urethane) chloride (Chloroethane)	9.05249	1.31309	1.20804	0.10505	0.00000	0.00000	0.00000
Ethylbenzene	150,602.95817	42,474.35029	4,068.01903	749.57434	37,656.75692	31,447.21216	6,209.54475
Ethylene dibromide (Dibromoethane)	57.53988	19.90017	19.21155	0.68862	0.00000	0.00000	0.00000
Ethylene dichloride (1,2-Dichloroethane)	4,198.60429	1,180.25331	1,160.03550	20.21781	0.00000	0.00000	0.00000
Ethylene glycol	12,310.94365	2,503.40104	2,341.98856	161.41248	0.00000	0.00000	0.00000
Ethylene oxide	2,761.74987	421.63663	208.33431	213.30232	0.00000	0.00000	0.00000
Ethylene thiourea	1.68367	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table 7-4 (continued)

188 HAP Name	Total Emissions (tpy)	Rural Emissions (tpy)					
		Total RURAL	POINT	AREA	Total MOBILE	MOBILE: On-Road	MOBILE: Non-Road
Ethylidene dichloride (1,1-Dichloroethane)	273.34234	46.05650	6.09522	39.96129	0.00000	0.00000	0.00000
Fine mineral fibers	0.44862	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Formaldehyde	347,326.51381	147,813.15612	7,751.22234	95,147.07637	44,914.85742	32,711.09843	12,203.75899
Glycol ethers	68,264.06943	11,084.42947	9,156.98153	1,927.44794	0.00000	0.00000	0.00000
Heptachlor	0.03100	0.00203	0.00201	0.00002	0.00000	0.00000	0.00000
Hexachlorobenzene	1.58467	0.28539	0.13069	0.15470	0.00000	0.00000	0.00000
Hexachlorobutadiene	15.09100	4.00776	3.95938	0.04838	0.00000	0.00000	0.00000
Hexachlorocyclopentadiene	4.07400	0.74415	0.65937	0.08478	0.00000	0.00000	0.00000
Hexachloroethane	25.54000	0.99980	0.94218	0.05762	0.00000	0.00000	0.00000
Hexamethylene diisocyanate	0.13974	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Hexane	188,727.94715	45,756.05548	8,653.70780	5,772.77867	31,329.56901	27,239.81791	4,089.75110
Hydrazine	20.46295	7.18377	6.38641	0.79735	0.00000	0.00000	0.00000
Hydrochloric acid (Hydrogen chloride [gas only])	339,677.12607	89,978.37702	84,427.51069	5,550.86632	0.00000	0.00000	0.00000
Hydrogen fluoride (Hydrofluoric acid)	33,883.94892	11,904.55757	11,295.70867	608.84890	0.00000	0.00000	0.00000
Hydroquinone	90.38896	21.41811	21.20395	0.21416	0.00000	0.00000	0.00000
Isophorone	402.62448	112.25797	92.36242	19.89555	0.00000	0.00000	0.00000
Lead Compounds	3,307.14259	568.29373	315.01780	66.64249	186.63345	141.23546	45.39799
Maleic anhydride	215.24860	23.76493	23.47362	0.29131	0.00000	0.00000	0.00000
Manganese Compounds	2,908.92074	901.28296	773.42321	115.51623	12.34352	7.32680	5.01672
Mercury Compounds	205.95234	42.29652	29.22674	10.25088	2.81890	1.67738	1.14152
Methanol	385,706.55818	132,421.18385	116,048.83320	16,372.35065	0.00000	0.00000	0.00000
Methoxychlor	0.04800	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Methyl bromide (Bromomethane)	30,984.83370	6,006.22336	1,401.93089	4,604.29247	0.00000	0.00000	0.00000
Methyl chloride (Chloromethane)	6,448.11666	1,027.50662	1,001.33650	26.17012	0.00000	0.00000	0.00000
Methyl chloroform (1,1,1-Trichloroethane)	214,949.10156	29,516.78200	17,388.26586	12,128.51614	0.00000	0.00000	0.00000
Methyl ethyl ketone (2-Butanone)	207,791.18347	24,344.89069	21,299.82628	3,045.06441	0.00000	0.00000	0.00000
Methyl iodide (Iodomethane)	36.85000	2.86474	2.73464	0.13010	0.00000	0.00000	0.00000
Methyl isobutyl ketone (Hexone)	35,693.57825	6,481.23304	5,592.38593	888.84712	0.00000	0.00000	0.00000
Methyl isocyanate	5.48950	0.55549	0.54601	0.00947	0.00000	0.00000	0.00000
Methyl methacrylate	1,844.52803	341.55778	309.80425	31.75353	0.00000	0.00000	0.00000
Methyl tert-butyl ether	14,433.46646	3,800.55502	526.30743	3,274.24759	0.00000	0.00000	0.00000
Methylene chloride (Dichloromethane)	124,285.50179	23,669.96577	10,136.82984	13,533.13592	0.00000	0.00000	0.00000
Methylhydrazine	0.01300	0.00164	0.00162	0.00002	0.00000	0.00000	0.00000
N,N-Dimethylaniline	22.57050	3.61632	0.41127	3.20505	0.00000	0.00000	0.00000
N,N-Dimethylformamide	3,284.93673	221.18470	213.85545	7.32925	0.00000	0.00000	0.00000
N-Nitrosodimethylamine	19.86900	1.47367	1.43303	0.04064	0.00000	0.00000	0.00000
N-Nitrosomorpholine	0.63000	0.15851	0.15693	0.00159	0.00000	0.00000	0.00000
Nickel Compounds	1,329.52989	133.55850	87.90174	26.68814	18.96861	5.25356	13.71506
Nitrobenzene	48.57008	3.72051	3.61943	0.10108	0.00000	0.00000	0.00000
Parathion	0.61000	0.00250	0.00242	0.00008	0.00000	0.00000	0.00000
Pentachloronitrobenzene (Quintobenzene)	2.45669	0.72400	0.70857	0.01543	0.00000	0.00000	0.00000
Pentachlorophenol	6.20350	3.62647	1.18639	2.44008	0.00000	0.00000	0.00000
Phenol	11,514.93212	3,579.43438	3,496.30248	83.13190	0.00000	0.00000	0.00000
Phosgene	4.57351	0.65671	0.63119	0.02552	0.00000	0.00000	0.00000
Phosphine	3.13436	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Phosphorus Compounds	161.98552	15.08522	11.39058	3.69464	0.00000	0.00000	0.00000
Phthalic anhydride	468.36056	42.67394	37.62948	5.04446	0.00000	0.00000	0.00000

Table 7-4 (continued)

188 HAP Name	Total Emissions (tpy)	Rural Emissions (tpy) Total RURAL	POINT	AREA	Total MOBILE	MOBILE: On-Road	MOBILE: Non-Road
Polychlorinated biphenyls (Aroclors)	0.04958	0.01114	0.00651	0.00463	0.00000	0.00000	0.00000
Polycyclic Organic Matter	17,535.29518	4,302.48255	1,148.69698	3,123.45099	30.33458	25.47270	4.86188
Propionaldehyde	14,187.80399	3,824.72492	1,024.37077	0.72001	2,799.63414	1,784.99814	1,014.63600
Propoxur (Baygon)	0.00500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Propylene dichloride (1,2-Dichloropropane)	654.98931	113.19208	108.30457	4.88750	0.00000	0.00000	0.00000
Propylene oxide	3,257.81786	317.84229	290.34756	27.49474	0.00000	0.00000	0.00000
Quinoline	26.02550	1.99690	1.92059	0.07631	0.00000	0.00000	0.00000
Quinone (p-Benzoquinone)	8.05050	1.05414	1.04371	0.01044	0.00000	0.00000	0.00000
Radionuclides (including radon)	7.80214	0.07922	0.07922	0.00000	0.00000	0.00000	0.00000
Selenium Compounds	355.37407	97.53965	93.81753	3.62789	0.09423	0.00000	0.09423
Styrene	56,139.36148	14,807.22739	7,531.53278	924.94923	6,350.74537	6,006.49246	344.25292
Styrene oxide	0.17600	0.00052	0.00052	0.00001	0.00000	0.00000	0.00000
Tetrachloroethylene (Perchloroethylene)	128,000.71200	22,691.80846	2,360.00113	20,331.80733	0.00000	0.00000	0.00000
Titanium tetrachloride	6.24600	0.52812	0.52266	0.00547	0.00000	0.00000	0.00000
Toluene	1,108,201.65839	315,400.23308	34,816.57241	42,408.27422	238,175.38645	213,465.58721	24,709.79924
Total Unspeciated HAPs	580,281.00000	71,463.86991	70,770.08156	693.78835	0.00000	0.00000	0.00000
Total Unspeciated METALS	64.31000	10.13487	10.03352	0.10135	0.00000	0.00000	0.00000
Trichloroethylene	71,998.64943	8,646.90290	6,917.76933	1,729.13357	0.00000	0.00000	0.00000
Triethylamine	443.52550	40.02497	22.14740	17.87757	0.00000	0.00000	0.00000
Trifluralin	10.15027	1.06461	1.03498	0.02963	0.00000	0.00000	0.00000
Unspeciated Particulate HAPs, Chromium and Cobalt	0.43000	0.05160	0.03818	0.01342	0.00000	0.00000	0.00000
Vinyl acetate	3,864.49624	583.34736	562.57442	20.77294	0.00000	0.00000	0.00000
Vinyl bromide	1.43700	0.11699	0.11574	0.00125	0.00000	0.00000	0.00000
Vinyl chloride	2,712.08592	322.27507	234.33828	87.93679	0.00000	0.00000	0.00000
Vinylidene chloride (1,1-Dichloroethylene)	223.89224	15.00740	7.31321	7.69419	0.00000	0.00000	0.00000
Xylenes (mixed isomers)	702,577.76064	192,995.90535	27,961.71324	20,293.01285	144,741.17926	120,013.41876	24,727.76050
o-Anisidine	0.82360	0.15196	0.15044	0.00152	0.00000	0.00000	0.00000
o-Toluidine	9.30050	0.57033	0.52772	0.04261	0.00000	0.00000	0.00000
p-Phenylenediamine	2.13950	0.29578	0.29284	0.00294	0.00000	0.00000	0.00000

Note(s): EPA uses a data base to store these emissions. Since the data base stores very large and very small amounts, the number of decimal places displayed are an artifact of that storage and are not intended to suggest true precision of large values.

The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-5. Baseline NTI (1990 to 1993)
188 HAPs by State (Point, Area, On-road, and Non-road)

	188-List HAP Emissions (tpy)				
State	Total	POINT	AREA	MOBILE: On-Road	MOBILE: Non-Road
Alabama	163,292	102,129	21,852	30,049	9,261
Alaska	101,454	2,740	91,932	5,310	1,473
Arizona	51,295	18,029	11,692	13,157	8,418
Arkansas	83,581	41,423	14,407	22,292	5,459
California	491,166	183,989	86,077	151,809	69,292
Colorado	66,905	20,295	19,672	19,078	7,859
Connecticut	76,732	46,829	10,488	11,887	7,528
Delaware	17,274	10,174	1,985	3,590	1,525
District of Columbia	6,583	693	1,530	2,981	1,379
Florida	200,415	57,177	40,473	72,504	30,261
Georgia	173,341	74,634	28,060	55,426	15,221
Hawaii	14,850	1,886	3,315	6,803	2,845
Idaho	29,366	3,522	13,154	10,317	2,372
Illinois	245,986	114,079	37,523	67,656	26,728
Indiana	157,964	82,172	23,024	39,949	12,818
Iowa	71,294	28,967	10,676	25,274	6,377
Kansas	72,201	34,186	10,949	21,327	5,739
Kentucky	118,633	57,740	17,522	34,715	8,656
Louisiana	166,927	111,097	18,764	27,307	9,759
Maine	45,066	22,696	10,507	8,967	2,896
Maryland	70,763	21,631	13,297	24,745	11,089
Massachusetts	84,371	28,126	17,990	24,140	14,116
Michigan	214,078	100,887	35,290	56,267	21,635
Minnesota	94,113	29,861	21,731	32,260	10,260
Mississippi	88,063	39,737	15,853	26,576	5,898
Missouri	135,396	59,561	22,888	40,733	12,214
Montana	31,037	6,186	14,938	8,027	1,887
Nebraska	34,778	10,816	6,242	14,041	3,679
Nevada	19,118	4,130	4,549	7,497	2,941
New Hampshire	24,909	9,869	5,327	7,135	2,578
New Jersey	172,543	106,049	21,108	27,488	17,897
New Mexico	35,493	7,027	10,637	14,276	3,552
New York	267,090	94,383	52,425	78,483	41,798
North Carolina	173,488	77,075	28,089	52,870	15,453
North Dakota	16,738	4,860	4,545	5,837	1,497
Ohio	256,532	125,774	38,453	67,255	25,049
Oklahoma	73,465	23,377	15,709	27,110	7,269
Oregon	74,757	27,695	21,023	19,305	6,734
Pennsylvania	227,812	102,692	39,771	57,595	27,755
Rhode Island	17,562	6,718	3,134	5,367	2,342
South Carolina	107,593	60,878	15,381	23,315	8,019
South Dakota	15,272	2,659	3,649	7,344	1,619
Tennessee	195,631	126,355	21,835	36,132	11,309
Texas	506,367	285,785	67,534	113,157	39,891
Utah	104,117	77,457	11,191	11,391	4,078
Vermont	11,928	1,371	3,307	5,928	1,321
Virginia	148,893	63,274	25,209	45,815	14,595
Washington	133,232	67,143	23,960	30,509	11,620
West Virginia	84,607	52,172	10,838	17,478	4,118
Wisconsin	125,329	57,360	21,349	35,349	11,271
Wyoming	16,350	3,960	6,547	4,747	1,096

Note(s): The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-6. Baseline NTI (1990 to 1993) 33 HAPs by State (Point, Area, On-road, and Non-road)

	33 Urban HAP Emissions (tpy)				
State	Total	POINT	AREA	MOBILE: On-Road	MOBILE: Non-Road
Alabama	31,634	9,694	11,482	7,226	3,231
Alaska	69,102	610	66,610	1,277	606
Arizona	14,933	2,290	6,525	3,163	2,955
Arkansas	20,631	4,594	8,736	5,361	1,940
California	125,546	29,954	34,308	36,507	24,777
Colorado	23,384	3,083	12,817	4,588	2,896
Connecticut	15,178	5,973	3,719	2,859	2,627
Delaware	3,138	1,065	684	863	526
District of Columbia	1,932	257	480	717	477
Florida	53,073	8,233	16,531	17,436	10,873
Georgia	43,658	10,016	14,807	13,329	5,507
Hawaii	4,577	378	1,432	1,636	1,131
Idaho	14,209	636	10,231	2,481	861
Illinois	51,251	12,365	13,003	16,270	9,612
Indiana	35,442	12,577	8,769	9,607	4,490
Iowa	15,161	3,065	3,779	6,078	2,240
Kansas	16,293	5,500	3,659	5,129	2,004
Kentucky	25,314	4,826	9,026	8,348	3,114
Louisiana	28,369	9,740	8,624	6,567	3,438
Maine	14,483	3,196	8,086	2,157	1,045
Maryland	17,841	3,013	4,931	5,951	3,946
Massachusetts	23,015	5,122	6,985	5,805	5,103
Michigan	49,053	11,437	16,397	13,531	7,688
Minnesota	25,884	4,095	10,349	7,758	3,682
Mississippi	22,873	5,476	8,958	6,391	2,048
Missouri	31,750	6,778	10,661	9,796	4,515
Montana	14,775	800	11,366	1,930	680
Nebraska	7,442	836	1,929	3,377	1,300
Nevada	5,733	553	2,253	1,803	1,124
New Hampshire	7,489	1,639	3,215	1,716	919
New Jersey	27,161	7,282	6,910	6,610	6,358
New Mexico	11,931	904	6,316	3,433	1,278
New York	71,368	17,392	20,171	18,874	14,932
North Carolina	41,541	8,996	14,293	12,714	5,537
North Dakota	3,292	394	960	1,404	534
Ohio	54,289	15,569	13,721	16,174	8,825
Oklahoma	20,979	4,260	7,644	6,520	2,556
Oregon	25,797	4,361	14,346	4,643	2,448
Pennsylvania	54,091	14,288	15,979	13,850	9,974
Rhode Island	3,996	646	1,220	1,291	839
South Carolina	22,818	6,825	7,571	5,607	2,815
South Dakota	3,936	233	1,358	1,766	580
Tennessee	29,904	7,110	10,096	8,689	4,009
Texas	95,759	28,265	25,913	27,212	14,369
Utah	12,322	2,273	5,821	2,739	1,488
Vermont	4,439	247	2,288	1,426	479
Virginia	35,320	6,153	12,852	11,018	5,297
Washington	36,234	10,519	14,123	7,337	4,255
West Virginia	15,959	3,873	6,443	4,203	1,441
Wisconsin	29,971	7,156	10,355	8,501	3,959
Wyoming	7,145	290	5,325	1,141	389

Note(s): The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-7. Baseline NTI (1990 to 1993)
33 HAPs by Tier 1

	Emissions (tpy) for Tier 1 Reporting Levels						
	01	02	03	04	05	06	07
NTI Pollutant Description	**FUEL COMB. ELEC. UTIL.**	**FUEL COMB. INDUSTRIAL**	**FUEL COMB. OTHER**	**CHEMICAL & ALLIED PRODUCT MFG**	**METALS PROCESSING**	**PETROLEUM & RELATED INDUSTRIES**	**OTHER INDUSTRIAL PROCESSES**
1,1,2,2-Tetrachloroethane	0.00000	0.00000	0.00000	17.78800	0.51700	0.01850	11.32150
Ethylene Dichloride	27.02126	0.81934	0.13473	2,898.72120	0.00190	91.81822	1,105.11616
Propylene Dichloride	0.00000	0.00001	0.00000	428.43400	0.00000	0.66500	201.84800
1,3-Butadiene	0.51750	48.74947	0.94777	3,277.96648	530.13000	152.43093	11.48258
Acetaldehyde	65.84379	2,300.74122	33.14230	6,657.73027	2.80059	61.96659	13,321.32602
Acrolein	28.55861	8.71325	1.33634	397.40819	11.10208	2.17710	308.81792
Acrylonitrile	0.00042	0.00000	0.00000	2,054.03964	0.62600	46.36117	24.34623
Arsenic & Compounds (inorganic including arsine)	61.48658	13.52304	7.44388	3.06196	106.28059	40.55300	44.21509
Benzene	37.84816	1,037.31036	32.46966	5,079.51076	2,771.11883	25,830.05279	2,076.41741
Beryllium & Compounds	7.17599	0.78875	2.10119	0.00056	0.91142	0.26163	0.90331
Cadmium & Compounds	4.00910	2.80706	3.10371	9.22847	131.77837	6.60694	15.72217
Carbon tetrachloride	0.00613	0.01472	0.00032	637.27465	0.00000	48.48671	4,282.45080
Chloroform	0.00540	0.03079	0.00986	1,746.31005	0.32800	1.78696	20,444.24719
Chromium & Compounds	76.64199	14.50598	7.02827	68.45539	137.89791	42.98149	431.04281
Coke Oven Emissions	0.00000	0.00000	0.00000	0.00000	826.73000	0.00000	0.00000
Ethylene Dibromide	0.00314	0.00345	0.00014	28.80755	0.00007	11.14484	7.38021
Ethylene Oxide	0.00000	0.00000	0.00000	949.76887	0.00000	9.11563	585.64322
Formaldehyde	198.76632	26,223.73958	685.19718	3,285.17222	134.38944	753.11352	9,829.56747
Hexachlorobenzene	0.00000	0.00010	0.00002	1.43850	0.00000	0.00000	0.00001
Hydrazine	0.00000	0.00000	0.10511	15.51250	0.50250	3.28905	0.63904
Lead & Compounds	87.08918	30.14759	17.83845	181.47978	839.68597	47.17316	552.67951
Manganese & Compounds	192.16294	547.20368	245.54949	222.08554	1,187.28718	50.00145	357.28506
Mercury & Compounds	53.28055	2.92661	3.13193	13.41729	3.45209	1.46299	10.53589
Methylene chloride	119.63081	9.09658	1.39897	45,291.70359	217.60550	29.39032	34,111.13747
Nickel & Compounds	450.48274	125.73762	120.67300	20.22190	88.27336	111.05618	253.55360
Polychlorinated biphenyls	0.00001	0.00499	0.00000	0.00000	0.00000	0.00000	0.00943
16-PAH	8.81088	218.44557	73.99793	865.61650	1,947.12400	1,317.14250	1,288.75071
Tetrachloroethylene	27.50444	1.29597	0.38331	668.97825	396.59375	17.88168	6,857.57749
Trichloroethylene	0.19297	7.53408	0.73649	383.98201	952.72172	67.64605	12,332.57601
Vinyl chloride	0.08442	0.68360	0.05934	2,154.41688	0.00000	4.65101	16.80269
1,3-Dichloropropene	0.00000	0.00000	0.00000	30.29300	0.78700	0.00000	0.00000
Quinoline	0.00000	0.00000	0.00000	12.49950	9.06150	4.37950	0.08500
2,3,7,8-TCDD TEQ	0.00011	0.00009	0.00004	0.00000	0.00020	0.00000	0.00007

Note(s): EPA uses a data base to store these emissions. Since the data base stores very large and very small amounts, the number of decimal places displayed are an artifact of that storage and are not intended to suggest true precision of large values.
The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-7 (continued)

	Emissions (tpy) for Tier 1 Reporting Levels						
	08	09	10	11	12	13	14
NTI Pollutant Description	SOLVENT UTILIZATION	STORAGE & TRANSPORT	WASTE DISPOSAL & RECYCLING	HIGHWAY VEHICLES	OFF-HIGHWAY	NATURAL SOURCES	MISC.
1,1,2,2-Tetrachloroethane	0.00000	0.00000	218.92334	0.00000	0.00000	0.00000	0.00000
Ethylene Dichloride	16.42611	7.48812	50.46048	0.00000	0.00000	0.00000	0.59675
Propylene Dichloride	0.00000	0.00000	24.04231	0.00000	0.00000	0.00000	0.00000
1,3-Butadiene	0.04703	24.35674	4.43295	36,657.97824	10,887.12866	0.00000	19,927.39934
Acetaldehyde	6.82552	0.05892	20.97927	27,963.87210	37,330.86678	0.00000	49,400.00000
Acrolein	1.01533	0.01852	24.12055	5,541.61622	6,729.03608	0.00000	49,606.34473
Acrylonitrile	2.26141	0.07673	415.88935	0.00000	0.00000	0.00000	0.00000
Arsenic & Compounds (inorganic including arsine)	0.01758	0.57411	7.78977	1.74759	1.04001	0.00001	0.69877
Benzene	278.28297	11,967.59638	629.87446	207,259.79811	72,411.29730	0.00000	59,936.33896
Beryllium & Compounds	0.00463	0.00435	0.17002	0.00000	0.02000	0.00000	0.05160
Cadmium & Compounds	0.91489	0.08872	24.37846	0.02668	0.31011	0.00003	0.14613
Carbon tetrachloride	0.43361	1.68034	70.03906	0.00000	0.00000	0.00000	0.12523
Chloroform	7.04926	1.76505	409.65664	0.00000	0.00000	0.00000	124.09405
Chromium & Compounds	51.91006	0.11269	12.39676	27.93068	25.83012	0.00038	0.41570
Coke Oven Emissions	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	936.96000
Ethylene Dibromide	4.97356	1.79958	3.42732	0.00000	0.00000	0.00000	0.00000
Ethylene Oxide	12.93591	0.03810	13.95000	0.00000	0.00000	0.00000	1,190.29814
Formaldehyde	733.66738	4.94350	27.75885	96,816.50994	79,405.52602	0.00000	129,228.16239
Hexachlorobenzene	0.00000	0.00000	0.00004	0.00000	0.00000	0.00000	0.14600
Hydrazine	0.31678	0.09795	0.00002	0.00000	0.00000	0.00000	0.00000
Lead & Compounds	76.84471	4.82841	270.92826	418.03935	778.25807	0.00019	2.14997
Manganese & Compounds	29.59095	5.58907	11.72747	21.68763	30.34058	0.00210	8.40762
Mercury & Compounds	0.01422	0.05540	103.12032	4.96458	6.93002	1.30002	1.36043
Methylene chloride	37,708.01972	18.39548	2,125.70399	0.00000	16.90000	0.00000	4,636.51936
Nickel & Compounds	35.68361	0.14186	28.06791	15.54908	79.33141	0.00011	0.75751
Polychlorinated biphenyls	0.00014	0.00102	0.03399	0.00000	0.00000	0.00000	0.00000
16-PAH	2,038.45400	729.08450	97.94350	75.93000	33.29000	0.00000	8,570.59160
Tetrachloroethylene	115,418.70645	17.23776	1,000.83989	9.50000	77.40000	0.00000	3,506.81301
Trichloroethylene	57,683.51050	3.69705	455.64005	0.00000	0.00000	0.00000	110.41250
Vinyl chloride	0.61149	0.00001	534.77648	0.00000	0.00000	0.00000	0.00000
1,3-Dichloropropene	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	19,896.79000
Quinoline	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2,3,7,8-TCDD TEQ	0.00000	0.00000	0.00194	0.00009	0.00000	0.00000	0.00009

Note(s): EPA uses a data base to store these emissions. Since the data base stores very large and very small amounts, the number of decimal places displayed are an artifact of that storage and are not intended to suggest true precision of large values.

The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-8. Baseline NTI (1990 to 1993) 33 HAPs by Tier 1 and Tier 2

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs						
		Acetaldehyde	Acrolein	Acrylonitrile	Arsenic Compounds	Benzene	Beryllium Compounds	1,3-Butadiene
01	FUEL COMB. ELEC. UTIL.	65.84379	28.55861	0.00042	61.48658	37.84816	7.17599	0.51750
01.00	MACT Categories (Utility Study)	64.19462	28.30971	0.00000	60.46005	29.14657	7.12285	0.36014
01.03	Gas	0.25463	0.07648	0.00000	0.00000	0.04787	0.00000	0.00000
01.04	Other	0.30662	0.02835	0.00000	0.00195	2.20616	0.00005	0.00000
01.05	Internal Combustion	1.08792	0.14408	0.00042	1.02458	6.44756	0.05309	0.15736
02	FUEL COMB. INDUSTRIAL	2,300.74122	8.71325	0.00000	13.52304	1,037.31036	0.78875	48.74947
02.00	MACT Categories	2,292.04293	7.71711	0.00000	13.26288	1,002.55945	0.75371	1.98873
02.01	Coal	0.03517	0.00042	0.00000	0.01053	9.05455	0.00048	0.00000
02.02	Oil	0.87134	0.12241	0.00000	0.22640	0.81561	0.03195	0.10793
02.03	Gas	4.87255	0.02470	0.00000	0.01464	21.07944	0.00095	46.53071
02.04	Other	0.00476	0.00005	0.00000	0.00533	0.51241	0.00089	0.06030
02.05	Internal Combustion	2.91446	0.84857	0.00000	0.00327	3.28891	0.00076	0.06180
03	FUEL COMB. OTHER	33.14230	1.33634	0.00000	7.44388	32.46966	2.10119	0.94777
03.00	MACT Categories	16.18344	0.68760	0.00000	3.70769	7.55116	0.78977	0.24371
03.02	Commercial/Institutional Oil	0.55004	0.01505	0.00000	0.00763	0.41253	0.00531	0.07661
03.03	Commercial/Institutional Gas	0.43899	0.09828	0.00000	0.01961	1.71404	0.00019	0.00286
03.04	Misc. Fuel Comb. (Except Residential)	0.38104	0.14941	0.00000	0.04603	6.56889	0.00792	0.62089
03.05	Residential Wood	0.00179	0.00000	0.00000	1.42692	2.03548	0.00000	0.00370
03.06	Residential Other	15.58700	0.38600	0.00000	2.23600	14.18756	1.29799	0.00000
04	CHEMICAL & ALLIED PRODUCT MFG	6,657.73027	397.40819	2,054.03964	3.06196	5,079.51076	0.00056	3,277.96648
04.00	MACT Categories	4,120.66428	2.73422	1,615.45564	0.13388	2,687.86522	0.00050	2,096.47393
04.01	Organic Chemicals	2,444.75350	394.54742	107.70650	0.00100	2,252.66142	0.00000	953.03592
04.02	Inorganic Chemicals	88.69400	0.12500	25.39300	0.69012	4.14883	0.00000	8.35850
04.03	Polymers & Resins	0.00000	0.00000	0.00000	0.00000	0.01550	0.00000	0.00000
04.04	Agricultural Chemicals	0.00000	0.00000	297.75000	1.92950	7.37080	0.00000	105.85500
04.05	Paints, Varnishs, Lacquers, Enamels	0.00000	0.00000	1.74400	0.00000	9.57115	0.00000	0.00000
04.06	Pharmaceuticals	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
04.07	Other Chemicals	0.33099	0.00055	2.39500	0.30746	110.85833	0.00006	113.14814
05	METALS PROCESSING	2.80059	11.10208	0.62600	106.28059	2,771.11883	0.91142	530.13000
05.00	MACT Categories	2.80045	11.10203	0.62600	102.53965	2,186.37923	0.35030	530.13000
05.01	Nonferrous Metals Processing	0.00004	0.00002	0.00000	3.49073	0.98044	0.55887	0.00000
05.02	Ferrous Metals Processing	0.00009	0.00003	0.00000	0.25000	583.45590	0.00200	0.00000
05.03	Metals Processing NEC	0.00000	0.00000	0.00000	0.00021	0.30325	0.00025	0.00000
06	PETROLEUM & RELATED INDUSTRIES	61.96659	2.17710	46.36117	40.55300	25,830.05279	0.26163	152.43093
06.00	MACT Categories	0.79533	0.00001	0.00000	40.54177	23,970.32152	0.25052	0.11581
06.01	Oil & Gas Production	0.16854	0.01195	0.00000	0.00002	73.37076	0.00010	0.26000
06.02	Petroleum Refineries & Related Industries	60.98623	2.16514	46.36117	0.00111	1,785.93468	0.00167	152.05268
06.03	Asphalt Manufacturing	0.01650	0.00000	0.00000	0.01010	0.42583	0.00935	0.00243
07	OTHER INDUSTRIAL PROCESSES	13,321.32602	308.81792	24.34623	44.21509	2,076.41741	0.90331	11.48258
07.00	MACT Categories	13,071.79777	307.42416	22.06650	14.34869	1,666.42971	0.61632	8.39130
07.01	Agriculture, Food, & Kindred Products	82.71730	0.00152	0.00000	14.38074	0.19494	0.00828	0.25020

Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs Acetaldehyde	Acrolein	Acrylonitrile	Arsenic Compounds	Benzene	Beryllium Compounds	1,3-Butadiene
07.02	Textiles, Leather, & Apparel Products	0.00027	0.00006	0.00000	0.00022	0.01947	0.00001	0.00000
07.03	Wood, Pulp & Paper, & Publishing Products	45.41750	0.00000	0.00000	3.43368	89.15750	0.00115	0.00000
07.04	Rubber & Miscellaneous Plastic Products	27.05000	0.00000	0.37500	0.00500	0.00000	0.00000	0.00000
07.05	Mineral Products	12.31814	0.02760	0.00350	2.17758	11.43984	0.02974	0.01567
07.06	Machinery Products	0.00000	0.00000	0.00000	0.03523	0.16965	0.00018	0.01000
07.07	Electronic Equipment	0.00000	0.00000	0.00000	0.00000	0.00000	0.00050	0.00000
07.08	Transportation Equipment	0.00365	0.00000	0.00000	0.00000	3.54225	0.00000	0.12500
07.09	Construction	0.00000	0.00000	0.00000	0.00000	7.12500	0.00000	0.00000
07.10	Miscellaneous Industrial Processes	82.02139	1.36458	1.90123	9.83394	298.33905	0.24714	2.69041
08	SOLVENT UTILIZATION	6.82552	1.01533	2.26141	0.01758	278.28297	0.00463	0.04703
08.00	MACT Categories	6.08343	1.01487	2.24426	0.01670	262.83717	0.00290	0.04703
08.01	Degreasing	0.00800	0.00000	0.01699	0.00000	0.32632	0.00000	0.00000
08.02	Graphic Arts	0.00000	0.00000	0.00000	0.00088	0.15300	0.00000	0.00000
08.03	Dry Cleaning	0.00000	0.00000	0.00000	0.00000	0.04111	0.00000	0.00000
08.04	Surface Coating	0.73410	0.00046	0.00016	0.00000	11.94199	0.00164	0.00000
08.05	Other Industrial	0.00000	0.00000	0.00000	0.00000	2.84619	0.00010	0.00000
08.06	Nonindustrial	0.00000	0.00000	0.00000	0.00000	0.13719	0.00000	0.00000
09	STORAGE & TRANSPORT	0.05892	0.01852	0.07673	0.57411	11,967.59638	0.00435	24.35674
09.00	MACT Categories	0.00000	0.00000	0.00000	0.00000	6,121.48618	0.00000	0.00000
09.01	Bulk Terminals & Plants	0.00000	0.00000	0.00000	0.00000	66.76307	0.00000	0.00002
09.02	Petroleum & Petroleum Product Storage	0.05826	0.01850	0.00000	0.00000	133.92712	0.00000	0.65293
09.03	Petroleum & Petroleum Product Transport	0.00026	0.00000	0.07672	0.00000	120.33242	0.00000	19.98118
09.04	Service Stations: Stage I	0.00000	0.00000	0.00000	0.00000	0.08668	0.00000	0.00000
09.05	Service Stations: Stage II	0.00000	0.00000	0.00000	0.00000	5,479.85855	0.00000	0.00000
09.06	Service Stations: Breathing & Emptying	0.00000	0.00000	0.00000	0.00000	0.00444	0.00000	0.00000
09.07	Organic Chemical Storage	0.00040	0.00003	0.00001	0.00000	27.35357	0.00000	0.37401
09.08	Organic Chemical Transport	0.00000	0.00000	0.00000	0.00000	12.09961	0.00000	3.34860
09.09	Inorganic Chemical Storage	0.00000	0.00000	0.00000	0.00003	1.24260	0.00000	0.00000
09.11	Bulk Materials Storage	0.00000	0.00000	0.00000	0.57408	4.44213	0.00435	0.00000
10	WASTE DISPOSAL & RECYCLING	20.97927	24.12055	415.88935	7.78977	629.87446	0.17002	4.43295
10.00	MACT Categories	20.03628	24.11002	415.88237	7.76883	602.34905	0.16974	1.58000
10.01	Incineration	0.00306	0.00000	0.00000	0.00060	0.01759	0.00017	0.00000
10.02	Open Burning	0.00000	0.00000	0.00000	0.00003	0.00006	0.00000	0.00000
10.04	Industrial Waste Water	0.92953	0.00316	0.00316	0.00000	22.46651	0.00000	2.84880
10.05	TSDF	0.00385	0.00382	0.00382	0.02007	0.36839	0.00000	0.00000
10.06	Landfills	0.00195	0.00020	0.00000	0.00000	4.56011	0.00000	0.00000
10.07	Other	0.00461	0.00335	0.00000	0.00025	0.11274	0.00010	0.00415
11	HIGHWAY VEHICLES	27,963.87210	5,541.61622	0.00000	1.74759	207,259.79811	0.00000	36,657.97824
12	OFF-HIGHWAY	37,330.86678	6,729.03608	0.00000	1.04001	72,411.29730	0.02000	10,887.12866
13	NATURAL SOURCES	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000
13.02	Geogenic	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000

Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs						
		Acetaldehyde	Acrolein	Acrylonitrile	Arsenic Compounds	Benzene	Beryllium Compounds	1,3-Butadiene
14	MISCELLANEOUS	49,400.00000	49,606.34473	0.00000	0.69877	59,936.33896	0.05160	19,927.39934
14.01	Agriculture & Forestry	0.00000	0.00000	0.00000	0.00021	0.00000	0.00000	0.00000
14.02	Other Combustion	49,400.00000	49,606.34472	0.00000	0.00937	55,617.00000	0.00000	19,927.39534
14.03	Catastrophic/Accidental Releases	0.00000	0.00000	0.00000	0.00000	4,250.00000	0.00000	0.00000
14.04	Repair Shops	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14.05	Health Services	0.00000	0.00000	0.00000	0.00000	0.01153	0.00000	0.00000
14.06	Cooling Towers	0.00000	0.00000	0.00000	0.67413	19.31538	0.05131	0.00000
14.07	Fugitive Dust	0.00000	0.00000	0.00000	0.01507	0.00000	0.00029	0.00000
14.21	Consumer Products Usage	0.00000	0.00000	0.00000	0.00000	0.58695	0.00000	0.00000
14.40	Transportation & Public Utilities	0.00000	0.00000	0.00000	0.00000	49.30000	0.00000	0.00000
14.70	Services	0.00000	0.00001	0.00000	0.00000	0.12510	0.00000	0.00400
14.98	Miscellaneous Categories	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Note(s): EPA uses a data base to store these emissions. Since the data base stores very large and very small amounts, the number of decimal places displayed are an artifact of that storage and are not intended to suggest true precision of large values.
The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-8 (continued)

		Emissions (tpy) for 33 Urban HAPs						
Tier Level Number	Tier Level Description	Cadmium Compounds	Carbon Tetrachloride	Chloroform	Chromium Compounds	Coke Oven Emissions	Ethylene Dibromide	Propylene Dichloride
01	FUEL COMB. ELEC. UTIL.	4.00910	0.00613	0.00540	76.64199	0.00000	0.00314	0.00000
01.00	MACT Categories (Utility Study)	3.73452	0.00004	0.00008	74.86615	0.00000	0.00027	0.00000
01.03	Gas	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
01.04	Other	0.01217	0.00000	0.00000	0.00125	0.00000	0.00185	0.00000
01.05	Internal Combustion	0.26241	0.00609	0.00533	1.77459	0.00000	0.00103	0.00000
02	FUEL COMB. INDUSTRIAL	2.80706	0.01472	0.03079	14.50598	0.00000	0.00345	0.00001
02.00	MACT Categories	2.74781	0.01405	0.02335	14.17409	0.00000	0.00345	0.00000
02.01	Coal	0.00603	0.00000	0.00000	0.00651	0.00000	0.00000	0.00000
02.02	Oil	0.03053	0.00000	0.00161	0.02665	0.00000	0.00000	0.00000
02.03	Gas	0.01150	0.00053	0.00573	0.00461	0.00000	0.00000	0.00001
02.04	Other	0.01015	0.00014	0.00011	0.00059	0.00000	0.00000	0.00000
02.05	Internal Combustion	0.00104	0.00000	0.00000	0.00353	0.00000	0.00000	0.00000
03	FUEL COMB. OTHER	3.10371	0.00032	0.00986	7.02827	0.00000	0.00014	0.00000
03.00	MACT Categories	1.36492	0.00000	0.00000	2.56996	0.00000	0.00000	0.00000
03.02	Commercial/Institutional Oil	0.00847	0.00000	0.00000	0.00682	0.00000	0.00000	0.00000
03.03	Commercial/Institutional Gas	0.00117	0.00029	0.00354	0.00044	0.00000	0.00014	0.00000
03.04	Misc. Fuel Comb. (Except Residential)	0.03937	0.00002	0.00631	0.13484	0.00000	0.00000	0.00000
03.05	Residential Wood	0.35188	0.00000	0.00000	2.70000	0.00000	0.00000	0.00000
03.06	Residential Other	1.33790	0.00000	0.00000	1.61620	0.00000	0.00000	0.00000
04	CHEMICAL & ALLIED PRODUCT MFG	9.22847	637.27465	1,746.31005	68.45539	0.00000	28.80755	428.43400
04.00	MACT Categories	0.26310	443.39652	744.27522	14.02728	0.00000	13.49750	120.09200
04.01	Organic Chemicals	0.37550	113.94050	944.79440	3.56250	0.00000	11.86000	102.37600
04.02	Inorganic Chemicals	8.24250	33.02151	11.74955	18.55200	0.00000	3.45000	0.00000
04.03	Polymers & Resins	0.00001	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000
04.04	Agricultural Chemicals	0.00000	40.36550	37.59400	1.65550	0.00000	0.00005	0.02600
04.05	Paints, Varnishs, Lacquers, Enamels	0.25620	0.00900	0.00000	9.71791	0.00000	0.00000	0.00000
04.06	Pharmaceuticals	0.00000	0.00000	0.06250	0.00000	0.00000	0.00000	0.00000
04.07	Other Chemicals	0.08616	1.50213	6.43189	11.44269	0.00000	0.00000	66.50000
05	METALS PROCESSING	131.77837	0.00000	0.32800	137.89791	826.73000	0.00007	0.00000
05.00	MACT Categories	120.54338	0.00000	0.32800	74.89745	826.73000	0.00007	0.00000
05.01	Nonferrous Metals Processing	4.96640	0.00000	0.00000	2.56650	0.00000	0.00000	0.00000
05.02	Ferrous Metals Processing	1.33703	0.00000	0.00000	54.76793	0.00000	0.00000	0.00000
05.03	Metals Processing NEC	4.93157	0.00000	0.00000	5.66603	0.00000	0.00000	0.00000
06	PETROLEUM & RELATED INDUSTRIES	6.60694	48.48671	1.78696	42.98149	0.00000	11.14484	0.66500
06.00	MACT Categories	6.57559	0.00000	0.00000	35.70247	0.00000	0.00000	0.00000
06.01	Oil & Gas Production	0.00003	0.00000	0.00435	0.02446	0.00000	0.00068	0.00000
06.02	Petroleum Refineries & Related Industries	0.02455	48.48671	1.75661	7.24354	0.00000	11.14216	0.66500
06.03	Asphalt Manufacturing	0.00678	0.00000	0.02600	0.01102	0.00000	0.00200	0.00000
07	OTHER INDUSTRIAL PROCESSES	15.72217	4,282.45080	20,444.24719	431.04281	0.00000	7.38021	201.84800
07.00	MACT Categories	3.58286	4,278.88550	18,511.93969	224.65670	0.00000	6.88424	6.84800
07.01	Agriculture, Food, & Kindred Products	0.06623	0.00024	29.33677	0.27248	0.00000	0.00000	0.00000

Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs						
		Cadmium Compounds	Carbon Tetrachloride	Chloroform	Chromium Compounds	Coke Oven Emissions	Ethylene Dibromide	Propylene Dichloride
07.02	Textiles, Leather, & Apparel Products	0.00000	0.00250	0.00247	0.00000	0.00000	0.00000	0.00000
07.03	Wood, Pulp & Paper, & Publishing Products	0.00852	0.00000	1,883.80450	16.97406	0.00000	0.00000	0.00000
07.04	Rubber & Miscellaneous Plastic Products	0.13351	0.00002	1.07700	5.61051	0.00000	0.00000	0.00000
07.05	Mineral Products	5.32566	0.21177	0.11261	1.77837	0.00000	0.42622	0.00000
07.06	Machinery Products	0.03468	0.00000	0.12200	16.94066	0.00000	0.00000	0.00000
07.07	Electronic Equipment	0.01236	0.00000	0.00602	0.67051	0.00000	0.00000	0.00000
07.08	Transportation Equipment	0.50250	0.01614	0.24048	8.73300	0.00000	0.00000	0.00000
07.09	Construction	0.00000	0.00000	0.00000	0.12500	0.00000	0.00000	0.00000
07.10	Miscellaneous Industrial Processes	6.05586	3.33463	17.60568	155.28152	0.00000	0.06975	195.00000
08	SOLVENT UTILIZATION	0.91489	0.43361	7.04926	51.91006	0.00000	4.97356	0.00000
08.00	MACT Categories	0.76562	0.10310	3.49434	50.82879	0.00000	4.97356	0.00000
08.01	Degreasing	0.00050	0.02528	2.35826	0.00134	0.00000	0.00000	0.00000
08.02	Graphic Arts	0.12571	0.00000	0.00000	0.00414	0.00000	0.00000	0.00000
08.03	Dry Cleaning	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
08.04	Surface Coating	0.00592	0.30522	0.15515	1.03479	0.00000	0.00000	0.00000
08.05	Other Industrial	0.01713	0.00000	1.04151	0.04100	0.00000	0.00000	0.00000
08.06	Nonindustrial	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
09	STORAGE & TRANSPORT	0.08872	1.68034	1.76505	0.11269	0.00000	1.79958	0.00000
09.00	MACT Categories	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
09.01	Bulk Terminals & Plants	0.00000	0.00000	0.09500	0.00000	0.00000	0.00182	0.00000
09.02	Petroleum & Petroleum Product Storage	0.00000	0.00000	0.02051	0.00000	0.00000	0.03503	0.00000
09.03	Petroleum & Petroleum Product Transport	0.00000	0.10966	0.41000	0.00000	0.00000	0.06822	0.00000
09.04	Service Stations: Stage I	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000
09.05	Service Stations: Stage II	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000
09.06	Service Stations: Breathing & Emptying	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
09.07	Organic Chemical Storage	0.00000	0.01919	0.74355	0.00003	0.00000	0.01450	0.00000
09.08	Organic Chemical Transport	0.00000	0.00000	0.34600	0.00000	0.00000	0.00000	0.00000
09.09	Inorganic Chemical Storage	0.00000	1.45150	0.00000	0.00000	0.00000	0.00000	0.00000
09.11	Bulk Materials Storage	0.08872	0.00000	0.00000	0.11267	0.00000	0.00000	0.00000
10	WASTE DISPOSAL & RECYCLING	24.37846	70.03906	409.65664	12.39676	0.00000	3.42732	24.04231
10.00	MACT Categories	24.37706	68.90418	408.02951	11.89049	0.00000	0.03851	24.04227
10.01	Incineration	0.00102	0.00014	0.00000	0.00036	0.00000	0.00000	0.00000
10.02	Open Burning	0.00004	0.00000	0.00000	0.00202	0.00000	0.00000	0.00000
10.04	Industrial Waste Water	0.00000	0.00351	0.42605	0.00000	0.00000	0.00347	0.00000
10.05	TSDF	0.00019	0.00382	0.22886	0.00383	0.00000	0.00382	0.00003
10.06	Landfills	0.00000	1.12741	0.95488	0.00000	0.00000	3.38152	0.00000
10.07	Other	0.00015	0.00000	0.00000	0.50007	0.00000	0.00000	0.00000
11	HIGHWAY VEHICLES	0.02668	0.00000	0.00000	27.93068	0.00000	0.00000	0.00000
12	OFF-HIGHWAY	0.31011	0.00000	0.00000	25.83012	0.00000	0.00000	0.00000
13	NATURAL SOURCES	0.00003	0.00000	0.00000	0.00038	0.00000	0.00000	0.00000
13.02	Geogenic	0.00003	0.00000	0.00000	0.00038	0.00000	0.00000	0.00000

Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs						
		Cadmium Compounds	Carbon Tetrachloride	Chloroform	Chromium Compounds	Coke Oven Emissions	Ethylene Dibromide	Propylene Dichloride
14	MISCELLANEOUS	0.14613	0.12523	124.09405	0.41570	936.96000	0.00000	0.00000
14.01	Agriculture & Forestry	0.00057	0.00000	0.00000	0.00317	0.00000	0.00000	0.00000
14.02	Other Combustion	0.00000	0.00000	0.00000	0.13824	0.00000	0.00000	0.00000
14.03	Catastrophic/Accidental Releases	0.00000	0.00000	0.00000	0.00000	936.96000	0.00000	0.00000
14.04	Repair Shops	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14.05	Health Services	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14.06	Cooling Towers	0.01072	0.00000	0.34926	0.03563	0.00000	0.00000	0.00000
14.07	Fugitive Dust	0.00779	0.00000	0.00000	0.10209	0.00000	0.00000	0.00000
14.21	Consumer Products Usage	0.00000	0.00005	123.23574	0.00000	0.00000	0.00000	0.00000
14.40	Transportation & Public Utilities	0.00000	0.00000	0.00776	0.00000	0.00000	0.00000	0.00000
14.70	Services	0.12705	0.12518	0.12786	0.13407	0.00000	0.00000	0.00000
14.98	Miscellaneous Categories	0.00000	0.00000	0.37342	0.00250	0.00000	0.00000	0.00000

Note(s): EPA uses a data base to store these emissions. Since the data base stores very large and very small amounts, the number of decimal places displayed are an artifact of that storage and are not intended to suggest true precision of large values.

The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-8 (continued)

		Emissions (tpy) for 33 Urban HAPs						
Tier Level Number	Tier Level Description	1,3-Dichloropropene	Ethylene Dichloride	Ethylene Oxide	Formaldehyde	Hexachlorobenzene	Hydrazine	Lead Compounds
01	FUEL COMB. ELEC. UTIL.	0.00000	27.02126	0.00000	198.76632	0.00000	0.00000	87.08918
01.00	MACT Categories (Utility Study)	0.00000	27.01860	0.00000	184.03877	0.00000	0.00000	84.79815
01.03	Gas	0.00000	0.00000	0.00000	3.94117	0.00000	0.00000	0.00000
01.04	Other	0.00000	0.00000	0.00000	2.45448	0.00000	0.00000	0.02569
01.05	Internal Combustion	0.00000	0.00266	0.00000	8.33191	0.00000	0.00000	2.26534
02	FUEL COMB. INDUSTRIAL	0.00000	0.81934	0.00000	26,223.73958	0.00010	0.00000	30.14759
02.00	MACT Categories	0.00000	0.81934	0.00000	26,180.75588	0.00001	0.00000	29.95608
02.01	Coal	0.00000	0.00000	0.00000	0.63555	0.00000	0.00000	0.09787
02.02	Oil	0.00000	0.00000	0.00000	1.62310	0.00000	0.00000	0.05826
02.03	Gas	0.00000	0.00000	0.00000	15.75798	0.00000	0.00000	0.01571
02.04	Other	0.00000	0.00000	0.00000	0.20191	0.00010	0.00000	0.01264
02.05	Internal Combustion	0.00000	0.00000	0.00000	24.76516	0.00000	0.00000	0.00702
03	FUEL COMB. OTHER	0.00000	0.13473	0.00000	685.19718	0.00002	0.10511	17.83845
03.00	MACT Categories	0.00000	0.08146	0.00000	222.79075	0.00000	0.00000	5.80823
03.02	Commercial/Institutional Oil	0.00000	0.00000	0.00000	1.51566	0.00000	0.00000	0.01901
03.03	Commercial/Institutional Gas	0.00000	0.00007	0.00000	20.38024	0.00000	0.00000	0.00052
03.04	Misc. Fuel Comb. (Except Residential)	0.00000	0.00000	0.00000	24.44219	0.00002	0.10511	0.10084
03.05	Residential Wood	0.00000	0.00000	0.00000	137.75778	0.00000	0.00000	7.54084
03.06	Residential Other	0.00000	0.05320	0.00000	278.31056	0.00000	0.00000	4.36900
04	CHEMICAL & ALLIED PRODUCT MFG	30.29300	2,898.72120	949.76887	3,285.17222	1.43850	15.51250	181.47978
04.00	MACT Categories	5.54750	1,680.60753	454.24307	2,398.51766	0.16700	5.61400	6.97896
04.01	Organic Chemicals	22.75000	1,092.08619	329.40205	781.28034	0.27550	3.16350	1.35850
04.02	Inorganic Chemicals	1.56500	0.00100	90.79500	16.75771	0.00000	6.32250	151.78850
04.03	Polymers & Resins	0.00000	0.00000	0.00000	1.55751	0.00000	0.00000	0.00270
04.04	Agricultural Chemicals	0.43050	92.70850	0.01750	32.60120	0.41500	0.39950	1.63300
04.05	Paints, Varnishs, Lacquers, Enamels	0.00000	0.00031	0.00000	5.15854	0.00000	0.00000	16.37704
04.06	Pharmaceuticals	0.00000	0.01500	0.00000	0.00000	0.00000	0.00000	0.00000
04.07	Other Chemicals	0.00000	24.30418	54.90425	24.33877	0.58100	0.00000	2.17059
05	METALS PROCESSING	0.78700	0.00190	0.00000	134.38944	0.00000	0.50250	839.68597
05.00	MACT Categories	0.78700	0.00190	0.00000	113.89825	0.00000	0.00000	608.49312
05.01	Nonferrous Metals Processing	0.00000	0.00000	0.00000	1.69118	0.00000	0.00000	117.67273
05.02	Ferrous Metals Processing	0.00000	0.00000	0.00000	17.80012	0.00000	0.00250	111.43993
05.03	Metals Processing NEC	0.00000	0.00000	0.00000	0.99990	0.00000	0.50000	2.08020
06	PETROLEUM & RELATED INDUSTRIES	0.00000	91.81822	9.11563	753.11352	0.00000	3.28905	47.17316
06.00	MACT Categories	0.00000	0.00004	0.00000	641.86998	0.00000	0.00000	19.75903
06.01	Oil & Gas Production	0.00000	0.00426	0.00713	13.59667	0.00000	0.00355	0.00063
06.02	Petroleum Refineries & Related Industries	0.00000	91.80292	9.10850	96.72015	0.00000	3.28550	24.15977
06.03	Asphalt Manufacturing	0.00000	0.01100	0.00000	0.92671	0.00000	0.00000	3.25372
07	OTHER INDUSTRIAL PROCESSES	0.00000	1,105.11616	585.64322	9,829.56747	0.00001	0.63904	552.67951
07.00	MACT Categories	0.00000	477.59950	304.90950	8,274.44728	0.00000	0.00000	166.22812
07.01	Agriculture, Food, & Kindred Products	0.00000	0.00024	37.80576	6.67127	0.00000	0.00000	0.19792

Table 7-8 (continued)

		Emissions (tpy) for 33 Urban HAPs						
Tier Level Number	Tier Level Description	1,3-Dichloropropene	Ethylene Dichloride	Ethylene Oxide	Formaldehyde	Hexachlorobenzene	Hydrazine	Lead Compounds
07.02	Textiles, Leather, & Apparel Products	0.00000	0.00247	0.00000	14.69051	0.00000	0.00000	0.25021
07.03	Wood, Pulp & Paper, & Publishing Products	0.00000	0.00027	0.00000	656.72680	0.00000	0.00000	0.09095
07.04	Rubber & Miscellaneous Plastic Products	0.00000	30.15000	72.69750	27.31086	0.00000	0.00000	11.10871
07.05	Mineral Products	0.00000	0.35566	0.00000	349.80365	0.00001	0.00000	1.97079
07.06	Machinery Products	0.00000	552.45550	41.50155	30.70440	0.00000	0.00000	4.04335
07.07	Electronic Equipment	0.00000	0.00000	20.31450	19.67500	0.00000	0.00000	6.28861
07.08	Transportation Equipment	0.00000	0.07281	0.00000	0.13040	0.00000	0.00000	6.04817
07.09	Construction	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
07.10	Miscellaneous Industrial Processes	0.00000	44.47970	108.41441	449.40730	0.00000	0.63904	356.45269
08	SOLVENT UTILIZATION	0.00000	16.42611	12.93591	733.66738	0.00000	0.31678	76.84471
08.00	MACT Categories	0.00000	16.10075	12.91973	720.39133	0.00000	0.31678	29.53012
08.01	Degreasing	0.00000	0.03292	0.00735	0.64807	0.00000	0.00000	0.03044
08.02	Graphic Arts	0.00000	0.00000	0.00000	1.55492	0.00000	0.00000	0.47462
08.03	Dry Cleaning	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
08.04	Surface Coating	0.00000	0.14259	0.00850	6.94803	0.00000	0.00000	46.72702
08.05	Other Industrial	0.00000	0.14985	0.00033	4.12502	0.00000	0.00000	0.08250
08.06	Nonindustrial	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
09	STORAGE & TRANSPORT	0.00000	7.48812	0.03810	4.94350	0.00000	0.09795	4.82841
09.00	MACT Categories	0.00000	2.57000	0.00000	0.00000	0.00000	0.00000	0.13451
09.01	Bulk Terminals & Plants	0.00000	0.01531	0.00000	0.00000	0.00000	0.00000	0.00052
09.02	Petroleum & Petroleum Product Storage	0.00000	0.05158	0.00400	3.17495	0.00000	0.00000	0.00024
09.03	Petroleum & Petroleum Product Transport	0.00000	0.20591	0.00000	0.08388	0.00000	0.00000	0.52733
09.04	Service Stations: Stage I	0.00000	0.00005	0.00000	0.00008	0.00000	0.00000	0.00000
09.05	Service Stations: Stage II	0.00000	4.63016	0.00000	0.00000	0.00000	0.00000	0.03917
09.06	Service Stations: Breathing & Emptying	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
09.07	Organic Chemical Storage	0.00000	0.01511	0.00000	0.98994	0.00000	0.09795	0.00073
09.08	Organic Chemical Transport	0.00000	0.00000	0.00000	0.00104	0.00000	0.00000	0.00000
09.09	Inorganic Chemical Storage	0.00000	0.00000	0.03410	0.00000	0.00000	0.00000	0.00025
09.11	Bulk Materials Storage	0.00000	0.00000	0.00000	0.67362	0.00000	0.00000	4.12566
10	WASTE DISPOSAL & RECYCLING	0.00000	50.46048	13.95000	27.75885	0.00004	0.00002	270.92826
10.00	MACT Categories	0.00000	47.08843	13.95000	26.13004	0.00000	0.00000	270.90760
10.01	Incineration	0.00000	0.00002	0.00000	0.03558	0.00004	0.00000	0.00959
10.02	Open Burning	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00847
10.04	Industrial Waste Water	0.00000	2.50549	0.00000	1.51330	0.00000	0.00002	0.00000
10.05	TSDF	0.00000	0.00001	0.00000	0.01628	0.00000	0.00000	0.00171
10.06	Landfills	0.00000	0.86653	0.00000	0.05385	0.00000	0.00000	0.00000
10.07	Other	0.00000	0.00000	0.00000	0.00979	0.00000	0.00000	0.00089
11	HIGHWAY VEHICLES	0.00000	0.00000	0.00000	96,816.50994	0.00000	0.00000	418.03935
12	OFF-HIGHWAY	0.00000	0.00000	0.00000	79,405.52602	0.00000	0.00000	778.25807
13	NATURAL SOURCES	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00019
13.02	Geogenic	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00019

Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs						
		1,3-Dichloropropene	Ethylene Dichloride	Ethylene Oxide	Formaldehyde	Hexachlorobenzene	Hydrazine	Lead Compounds
14	MISCELLANEOUS	19,896.79000	0.59675	1,190.29814	129,228.16239	0.14600	0.00000	2.14997
14.01	Agriculture & Forestry	0.00000	0.00000	0.00000	0.00000	0.14600	0.00000	0.00166
14.02	Other Combustion	0.00000	0.00000	0.00000	129,070.85857	0.00000	0.00000	0.01649
14.03	Catastrophic/Accidental Releases	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14.04	Repair Shops	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14.05	Health Services	0.00000	0.01600	1,190.27814	0.00260	0.00000	0.00000	0.00313
14.06	Cooling Towers	0.00000	0.00000	0.00000	0.00880	0.00000	0.00000	1.68964
14.07	Fugitive Dust	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.15206
14.21	Consumer Products Usage	19,896.79000	0.57825	0.00000	156.68722	0.00000	0.00000	0.00000
14.40	Transportation & Public Utilities	0.00000	0.00000	0.02000	0.00000	0.00000	0.00000	0.00000
14.70	Services	0.00000	0.00250	0.00000	0.47769	0.00000	0.00000	0.28700
14.98	Miscellaneous Categories	0.00000	0.00000	0.00000	0.12750	0.00000	0.00000	0.00000

Note(s): EPA uses a data base to store these emissions. Since the data base stores very large and very small amounts, the number of decimal places displayed are an artifact of that storage and are not intended to suggest true precision of large values.

The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-8 (continued)

		Emissions (tpy) for 33 Urban HAPs						
Tier Level Number	Tier Level Description	Manganese Compounds	Mercury Compounds	Methylene Chloride	Nickel Compounds	Polychlorinated Biphenyls	Polycyclic Organic Matter	Quinoline
01	FUEL COMB. ELEC. UTIL.	192.16294	53.28055	119.63081	450.48274	0.00001	8.81088	0.00000
01.00	MACT Categories (Utility Study)	190.99779	52.08865	110.15984	448.74027	0.00000	8.81088	0.00000
01.03	Gas	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
01.04	Other	0.29501	0.00919	0.00000	0.01400	0.00000	0.00000	0.00000
01.05	Internal Combustion	0.87014	1.18271	9.46816	1.72825	0.00001	0.00000	0.00000
02	FUEL COMB. INDUSTRIAL	547.20368	2.92661	9.09658	125.73762	0.00499	218.44557	0.00000
02.00	MACT Categories	536.69908	2.38456	7.03388	93.90579	0.00499	218.44557	0.00000
02.01	Coal	0.01076	0.12113	0.00000	0.01991	0.00000	0.00000	0.00000
02.02	Oil	5.28795	0.36289	0.00000	31.20463	0.00000	0.00000	0.00000
02.03	Gas	4.91574	0.05066	2.06270	0.32189	0.00000	0.00000	0.00000
02.04	Other	0.03269	0.00668	0.00000	0.00954	0.00000	0.00000	0.00000
02.05	Internal Combustion	0.00247	0.00070	0.00000	0.01837	0.00000	0.00000	0.00000
03	FUEL COMB. OTHER	245.54949	3.13193	1.39897	120.67300	0.00000	73.99793	0.00000
03.00	MACT Categories	26.25095	1.65077	0.59591	118.09507	0.00000	9.84268	0.00000
03.02	Commercial/Institutional Oil	0.01545	0.00107	0.00000	0.03374	0.00000	0.00000	0.00000
03.03	Commercial/Institutional Gas	0.00101	0.00002	0.41637	0.08466	0.00000	0.00000	0.00000
03.04	Misc. Fuel Comb. (Except Residential)	0.03569	0.01245	0.00068	0.46466	0.00000	0.00000	0.00000
03.05	Residential Wood	216.05439	0.08712	0.00000	0.35187	0.00000	59.20000	0.00000
03.06	Residential Other	3.19200	1.38050	0.38600	1.64300	0.00000	4.95525	0.00000
04	CHEMICAL & ALLIED PRODUCT MFG	222.08554	13.41729	45,291.70359	20.22190	0.00000	865.61650	12.49950
04.00	MACT Categories	33.48464	13.04158	42,792.32555	2.45846	0.00000	449.01850	12.49950
04.01	Organic Chemicals	3.92300	0.02000	1,120.04803	2.16100	0.00000	328.47250	0.00000
04.02	Inorganic Chemicals	161.43550	0.25500	290.61901	13.08670	0.00000	15.68550	0.00000
04.03	Polymers & Resins	0.00000	0.00000	0.02568	0.00000	0.00000	0.00000	0.00000
04.04	Agricultural Chemicals	13.04350	0.00000	176.04545	0.26000	0.00000	5.95800	0.00000
04.05	Paints, Varnishs, Lacquers, Enamels	0.14700	0.01286	230.10029	0.53149	0.00000	30.72450	0.00000
04.06	Pharmaceuticals	0.00000	0.00000	5.67350	0.00000	0.00000	0.00000	0.00000
04.07	Other Chemicals	0.12340	0.08785	437.91909	0.51325	0.00000	19.54550	0.00000
05	METALS PROCESSING	1,187.28718	3.45209	217.60550	88.27336	0.00000	1,947.12400	9.06150
05.00	MACT Categories	897.44454	2.08314	132.13300	27.06591	0.00000	1,897.91050	9.01600
05.01	Nonferrous Metals Processing	9.39394	1.11895	1.07500	24.85529	0.00000	4.55000	0.00000
05.02	Ferrous Metals Processing	268.92111	0.25000	77.59500	29.78217	0.00000	44.66350	0.04550
05.03	Metals Processing NEC	11.52759	0.00000	6.80250	6.56999	0.00000	0.00000	0.00000
06	PETROLEUM & RELATED INDUSTRIES	50.00145	1.46299	29.39032	111.05618	0.00000	1,317.14250	4.37950
06.00	MACT Categories	44.95142	1.41880	0.44280	96.25919	0.00000	1,183.30000	0.00000
06.01	Oil & Gas Production	0.00109	0.00011	0.52404	0.01669	0.00000	0.00000	0.00000
06.02	Petroleum Refineries & Related Industries	1.71606	0.01759	28.42349	14.71855	0.00000	133.84250	4.37950
06.03	Asphalt Manufacturing	3.33288	0.02649	0.00000	0.06174	0.00000	0.00000	0.00000
07	OTHER INDUSTRIAL PROCESSES	357.28506	10.53589	34,111.13747	253.55360	0.00943	1,288.75071	0.08500
07.00	MACT Categories	134.49120	6.11607	19,993.04737	18.84583	0.00002	839.55500	0.00000
07.01	Agriculture, Food, & Kindred Products	17.83476	0.01790	157.27200	0.33123	0.00000	0.00500	0.00000

Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs						
		Manganese Compounds	Mercury Compounds	Methylene Chloride	Nickel Compounds	Polychlorinated Biphenyls	Polycyclic Organic Matter	Quinoline
07.02	Textiles, Leather, & Apparel Products	0.12202	0.00006	161.60232	0.62105	0.00000	4.49500	0.00000
07.03	Wood, Pulp & Paper, & Publishing Products	1.48555	0.01646	156.30500	1.60210	0.00000	97.07463	0.08500
07.04	Rubber & Miscellaneous Plastic Products	0.89752	0.12750	1,933.79475	0.53050	0.00000	153.94500	0.00000
07.05	Mineral Products	4.94522	1.36707	29.40403	0.92923	0.00360	2.83300	0.00000
07.06	Machinery Products	63.38068	0.00972	367.61153	26.45347	0.00000	1.03250	0.00000
07.07	Electronic Equipment	4.45400	0.88200	1,556.83564	2.93605	0.00000	0.00000	0.00000
07.08	Transportation Equipment	9.05351	0.00000	610.56981	10.48501	0.00031	14.21400	0.00000
07.09	Construction	0.12500	0.00000	0.00000	0.12500	0.00000	0.00000	0.00000
07.10	Miscellaneous Industrial Processes	120.49558	1.99911	9,144.69502	190.69414	0.00550	175.59658	0.00000
08	SOLVENT UTILIZATION	29.59095	0.01422	37,708.01972	35.68361	0.00014	2,038.45400	0.00000
08.00	MACT Categories	29.38422	0.01307	37,194.84156	35.23238	0.00000	2,028.02600	0.00000
08.01	Degreasing	0.09402	0.00004	116.62344	0.00194	0.00000	0.00000	0.00000
08.02	Graphic Arts	0.00001	0.00088	80.93048	0.00000	0.00014	10.42800	0.00000
08.03	Dry Cleaning	0.00000	0.00000	5.61650	0.00000	0.00000	0.00000	0.00000
08.04	Surface Coating	0.11269	0.00018	261.54303	0.44923	0.00000	0.00000	0.00000
08.05	Other Industrial	0.00000	0.00005	48.19188	0.00006	0.00000	0.00000	0.00000
08.06	Nonindustrial	0.00000	0.00000	0.27283	0.00000	0.00000	0.00000	0.00000
09	STORAGE & TRANSPORT	5.58907	0.05540	18.39548	0.14186	0.00102	729.08450	0.00000
09.00	MACT Categories	0.00000	0.00000	0.00000	0.00000	0.00000	354.51000	0.00000
09.01	Bulk Terminals & Plants	0.00000	0.00000	0.00000	0.00001	0.00000	0.57450	0.00000
09.02	Petroleum & Petroleum Product Storage	0.00023	0.00003	0.00310	0.01319	0.00000	0.00000	0.00000
09.03	Petroleum & Petroleum Product Transport	0.00000	0.00000	11.33791	0.00398	0.00000	0.00000	0.00000
09.04	Service Stations: Stage I	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
09.05	Service Stations: Stage II	0.00000	0.00000	0.00000	0.00000	0.00000	374.00000	0.00000
09.06	Service Stations: Breathing & Emptying	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
09.07	Organic Chemical Storage	0.00000	0.00005	4.02173	0.00000	0.00000	0.00000	0.00000
09.08	Organic Chemical Transport	0.00000	0.00000	1.42274	0.00000	0.00000	0.00000	0.00000
09.09	Inorganic Chemical Storage	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
09.11	Bulk Materials Storage	5.58884	0.05533	0.00000	0.12468	0.00102	0.00000	0.00000
10	WASTE DISPOSAL & RECYCLING	11.72747	103.12032	2,125.70399	28.06791	0.03399	97.94350	0.00000
10.00	MACT Categories	11.60955	101.54027	2,087.15277	27.55146	0.03339	97.94350	0.00000
10.01	Incineration	0.02441	0.07402	0.00060	0.00630	0.00060	0.00000	0.00000
10.02	Open Burning	0.00254	0.00000	0.00000	0.00159	0.00000	0.00000	0.00000
10.04	Industrial Waste Water	0.00000	0.00000	0.19973	0.00000	0.00000	0.00000	0.00000
10.05	TSDF	0.08076	0.00000	0.01694	0.00809	0.00000	0.00000	0.00000
10.06	Landfills	0.00000	0.00000	38.33363	0.00000	0.00000	0.00000	0.00000
10.07	Other	0.01020	1.50602	0.00001	0.50047	0.00000	0.00000	0.00000
11	HIGHWAY VEHICLES	21.68763	4.96458	0.00000	15.54908	0.00000	75.93000	0.00000
12	OFF-HIGHWAY	30.34058	6.93002	16.90000	79.33141	0.00000	33.29000	0.00000
13	NATURAL SOURCES	0.00210	1.30002	0.00000	0.00011	0.00000	0.00000	0.00000
13.02	Geogenic	0.00210	1.30002	0.00000	0.00011	0.00000	0.00000	0.00000

Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs: Manganese Compounds	Mercury Compounds	Methylene Chloride	Nickel Compounds	Polychlorinated Biphenyls	Polycyclic Organic Matter	Quinoline
14	MISCELLANEOUS	8.40762	1.36043	4,636.51936	0.75751	0.00000	8,570.59160	0.00000
14.01	Agriculture & Forestry	0.01889	0.00021	0.00000	0.00104	0.00000	0.00000	0.00000
14.02	Other Combustion	0.00236	0.00000	0.00000	0.12900	0.00000	2,837.82500	0.00000
14.03	Catastrophic/Accidental Releases	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14.04	Repair Shops	0.00000	0.00000	7.50000	0.00000	0.00000	0.00000	0.00000
14.05	Health Services	0.12500	0.00000	0.13550	0.00000	0.00000	0.00000	0.00000
14.06	Cooling Towers	7.51104	0.30045	0.00000	0.07012	0.00000	0.00000	0.00000
14.07	Fugitive Dust	0.73113	0.00498	0.00000	0.04692	0.00000	0.00000	0.00000
14.21	Consumer Products Usage	0.00000	0.00000	4,562.11623	0.00000	0.00000	5,732.76260	0.00000
14.40	Transportation & Public Utilities	0.00000	0.00000	17.00000	0.00000	0.00000	0.00000	0.00000
14.70	Services	0.01670	1.05479	40.23963	0.25792	0.00000	0.00400	0.00000
14.98	Miscellaneous Categories	0.00250	0.00000	9.52800	0.25250	0.00000	0.00000	0.00000

Note(s): EPA uses a data base to store these emissions. Since the data base stores very large and very small amounts, the number of decimal places displayed are an artifact of that storage and are not intended to suggest true precision of large values.

The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs: 2,3,7,8-Tetrachlorodibenzo-p-dioxin	1,1,2,2-Tetrachloroethane	Tetrachloroethylene	Trichloroethylene	Vinyl Chloride
01	FUEL COMB. ELEC. UTIL.	0.00011	0.00000	27.50444	0.19297	0.08442
01.00	MACT Categories (Utility Study)	0.00011	0.00000	27.02311	0.00073	0.00169
01.03	Gas	0.00000	0.00000	0.00000	0.00000	0.00000
01.04	Other	0.00000	0.00000	0.00000	0.00000	0.00000
01.05	Internal Combustion	0.00000	0.00000	0.48133	0.19224	0.08274
02	FUEL COMB. INDUSTRIAL	0.00009	0.00000	1.29597	7.53408	0.68360
02.00	MACT Categories	0.00009	0.00000	0.82278	1.11300	0.56920
02.01	Coal	0.00000	0.00000	0.00000	0.00000	0.00000
02.02	Oil	0.00000	0.00000	0.00000	0.00000	0.00000
02.03	Gas	0.00000	0.00000	0.47306	0.15108	0.11437
02.04	Other	0.00000	0.00000	0.00012	0.00000	0.00003
02.05	Internal Combustion	0.00000	0.00000	0.00000	0.00000	0.00000
03	FUEL COMB. OTHER	0.00004	0.00000	0.38331	0.73649	0.05934
03.00	MACT Categories	0.00000	0.00000	0.08760	0.00000	0.00000
03.02	Commercial/Institutional Oil	0.00000	0.00000	0.00000	0.00012	0.00000
03.03	Commercial/Institutional Gas	0.00000	0.00000	0.23748	0.06542	0.05933
03.04	Misc. Fuel Comb. (Except Residential)	0.00000	0.00000	0.00104	0.67095	0.00001
03.05	Residential Wood	0.00004	0.00000	0.00000	0.00000	0.00000
03.06	Residential Other	0.00000	0.00000	0.05720	0.00000	0.00000
04	CHEMICAL & ALLIED PRODUCT MFG	0.00000	17.78800	668.97825	383.98201	2,154.41688
04.00	MACT Categories	0.00000	0.82850	136.77345	239.14615	2,034.06416
04.01	Organic Chemicals	0.00000	16.95450	401.75783	136.12234	92.97800
04.02	Inorganic Chemicals	0.00000	0.00000	1.90333	0.59952	0.00000
04.03	Polymers & Resins	0.00000	0.00000	0.00000	0.00000	0.00000
04.04	Agricultural Chemicals	0.00000	0.00000	61.15000	1.03650	0.65650
04.05	Paints, Varnishs, Lacquers, Enamels	0.00000	0.00000	1.77812	1.01450	0.00002
04.06	Pharmaceuticals	0.00000	0.00000	0.00000	0.00000	0.00000
04.07	Other Chemicals	0.00000	0.00000	43.31002	3.77800	0.00519
05	METALS PROCESSING	0.00020	0.51700	396.59375	952.72172	0.00000
05.00	MACT Categories	0.00001	0.51700	184.25175	243.57250	0.00000
05.01	Nonferrous Metals Processing	0.00019	0.00000	153.54200	98.80000	0.00000
05.02	Ferrous Metals Processing	0.00000	0.00000	16.20450	456.24000	0.00000
05.03	Metals Processing NEC	0.00000	0.00000	42.59550	154.10923	0.00000
06	PETROLEUM & RELATED INDUSTRIES	0.00000	0.01850	17.88168	67.64605	4.65101
06.00	MACT Categories	0.00000	0.00000	0.00000	1.27500	0.00000
06.01	Oil & Gas Production	0.00000	0.00000	0.56970	19.59000	0.00000
06.02	Petroleum Refineries & Related Industries	0.00000	0.01850	17.31199	46.78105	4.65101
06.03	Asphalt Manufacturing	0.00000	0.00000	0.00000	0.00000	0.00000
07	OTHER INDUSTRIAL PROCESSES	0.00007	11.32150	6,857.57749	12,332.57601	16.80269
07.00	MACT Categories	0.00004	6.32050	1,092.73435	1,195.33839	9.50675
07.01	Agriculture, Food, & Kindred Products	0.00000	0.00000	0.00000	0.00000	0.00097

Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs: 2,3,7,8-Tetrachlorodibenzo-p-dioxin	1,1,2,2-Tetrachloroethane	Tetrachloroethylene	Trichloroethylene	Vinyl Chloride
07.02	Textiles, Leather, & Apparel Products	0.00000	0.00000	23.70500	30.17000	0.00000
07.03	Wood, Pulp & Paper, & Publishing Products	0.00003	0.00000	25.21850	39.92000	0.00000
07.04	Rubber & Miscellaneous Plastic Products	0.00000	5.00000	364.65219	377.30614	7.20065
07.05	Mineral Products	0.00000	0.00100	0.40136	475.31225	0.00013
07.06	Machinery Products	0.00000	0.00000	396.10185	310.68200	0.00000
07.07	Electronic Equipment	0.00000	0.00000	466.42138	895.17700	0.00000
07.08	Transportation Equipment	0.00000	0.00000	517.04844	695.87868	0.00000
07.09	Construction	0.00000	0.00000	0.00000	0.00000	0.00000
07.10	Miscellaneous Industrial Processes	0.00000	0.00000	3,971.29441	8,312.79155	0.09419
08	SOLVENT UTILIZATION	0.00000	0.00000	115,418.70645	57,683.51050	0.61149
08.00	MACT Categories	0.00000	0.00000	112,832.57270	57,541.69178	0.60908
08.01	Degreasing	0.00000	0.00000	22.53234	2.02712	0.00000
08.02	Graphic Arts	0.00000	0.00000	75.97817	27.26150	0.00000
08.03	Dry Cleaning	0.00000	0.00000	2,172.05504	0.00002	0.00000
08.04	Surface Coating	0.00000	0.00000	314.75481	111.53614	0.00241
08.05	Other Industrial	0.00000	0.00000	0.81338	0.99394	0.00000
08.06	Nonindustrial	0.00000	0.00000	0.00000	0.00000	0.00000
09	STORAGE & TRANSPORT	0.00000	0.00000	17.23776	3.69705	0.00001
09.00	MACT Categories	0.00000	0.00000	0.00000	0.00000	0.00000
09.01	Bulk Terminals & Plants	0.00000	0.00000	0.00000	0.00000	0.00000
09.02	Petroleum & Petroleum Product Storage	0.00000	0.00000	0.00000	0.00580	0.00000
09.03	Petroleum & Petroleum Product Transport	0.00000	0.00000	4.88874	2.17649	0.00000
09.04	Service Stations: Stage I	0.00000	0.00000	2.62625	0.00000	0.00000
09.05	Service Stations: Stage II	0.00000	0.00000	0.00000	0.00000	0.00000
09.06	Service Stations: Breathing & Emptying	0.00000	0.00000	0.00000	0.00000	0.00000
09.07	Organic Chemical Storage	0.00000	0.00000	0.68403	1.29631	0.00001
09.08	Organic Chemical Transport	0.00000	0.00000	9.03874	0.16845	0.00000
09.09	Inorganic Chemical Storage	0.00000	0.00000	0.00000	0.00000	0.00000
09.11	Bulk Materials Storage	0.00000	0.00000	0.00000	0.00000	0.00000
10	WASTE DISPOSAL & RECYCLING	0.00194	218.92334	1,000.83989	455.64005	534.77648
10.00	MACT Categories	0.00194	218.92334	980.95980	446.59199	527.89334
10.01	Incineration	0.00000	0.00000	0.00001	0.00000	0.00001
10.02	Open Burning	0.00000	0.00000	0.00000	0.00000	0.00000
10.04	Industrial Waste Water	0.00000	0.00000	0.09646	0.00850	0.00055
10.05	TSDF	0.00000	0.00000	0.16628	0.09501	0.00000
10.06	Landfills	0.00000	0.00000	19.61733	8.94453	6.88258
10.07	Other	0.00000	0.00000	0.00000	0.00001	0.00000
11	HIGHWAY VEHICLES	0.00009	0.00000	9.50000	0.00000	0.00000
12	OFF-HIGHWAY	0.00000	0.00000	77.40000	0.00000	0.00000
13	NATURAL SOURCES	0.00000	0.00000	0.00000	0.00000	0.00000
13.02	Geogenic	0.00000	0.00000	0.00000	0.00000	0.00000

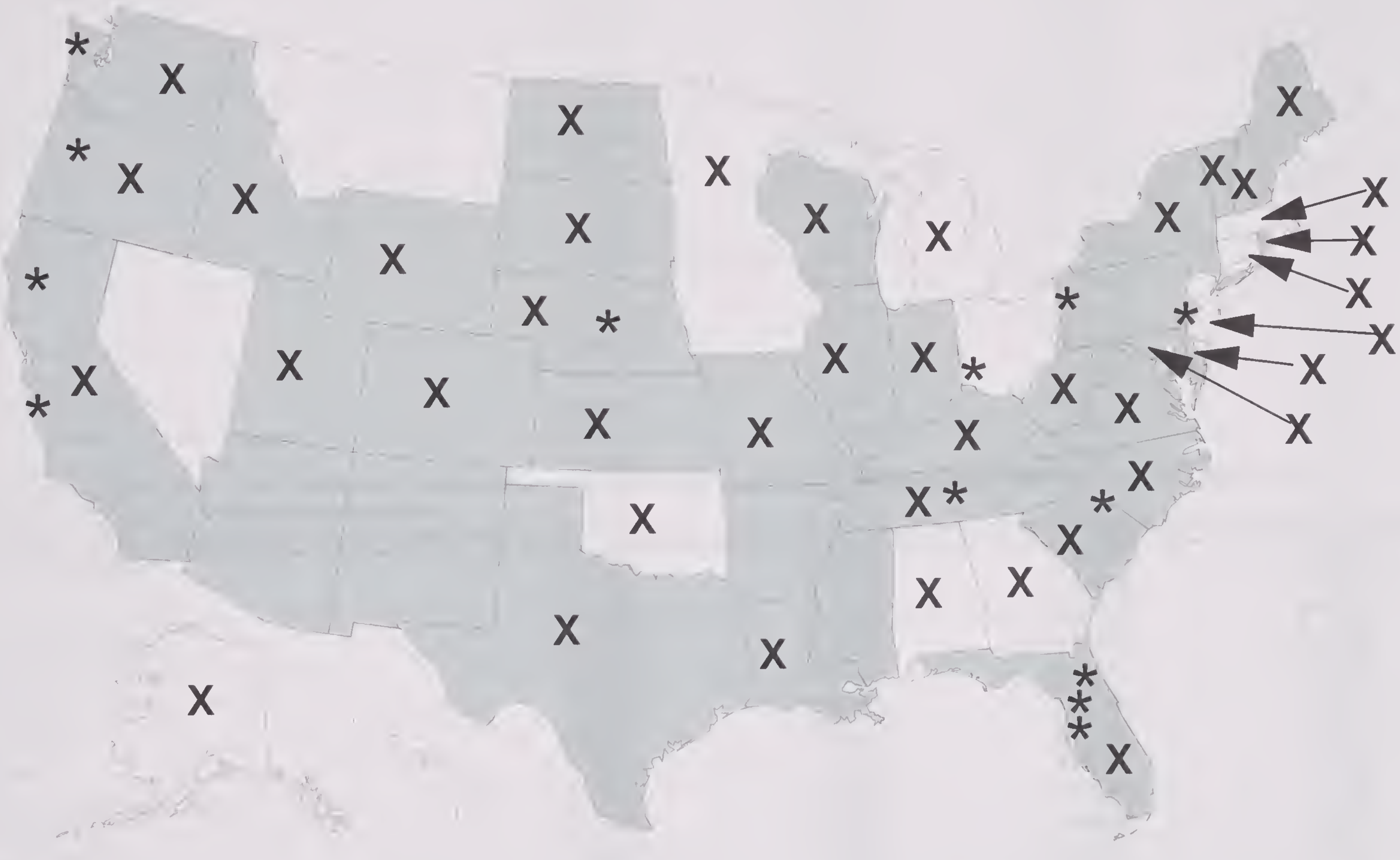
Table 7-8 (continued)

Tier Level Number	Tier Level Description	Emissions (tpy) for 33 Urban HAPs 2,3,7,8-Tetrachlorodibenzo-p-dioxin	1,1,2,2-Tetrachloroethane	Tetrachloroethylene	Trichloroethylene	Vinyl Chloride
14	MISCELLANEOUS	0.00009	0.00000	3,506.81301	110.41250	0.00000
14.01	Agriculture & Forestry	0.00000	0.00000	0.00000	0.00000	0.00000
14.02	Other Combustion	0.00009	0.00000	0.00000	0.00000	0.00000
14.03	Catastrophic/Accidental Releases	0.00000	0.00000	0.00000	0.00000	0.00000
14.04	Repair Shops	0.00000	0.00000	0.00000	0.00000	0.00000
14.05	Health Services	0.00000	0.00000	0.00000	0.00000	0.00000
14.06	Cooling Towers	0.00000	0.00000	0.00000	0.00000	0.00000
14.07	Fugitive Dust	0.00000	0.00000	0.00000	0.00000	0.00000
14.21	Consumer Products Usage	0.00000	0.00000	3,506.80921	60.43650	0.00000
14.40	Transportation & Public Utilities	0.00000	0.00000	0.00380	0.00150	0.00000
14.70	Services	0.00000	0.00000	0.00000	38.42500	0.00000
14.98	Miscellaneous Categories	0.00000	0.00000	0.00000	11.54950	0.00000

Note(s): EPA uses a data base to store these emissions. Since the data base stores very large and very small amounts, the number of decimal places displayed are an artifact of that storage and are not intended to suggest true precision of large values.

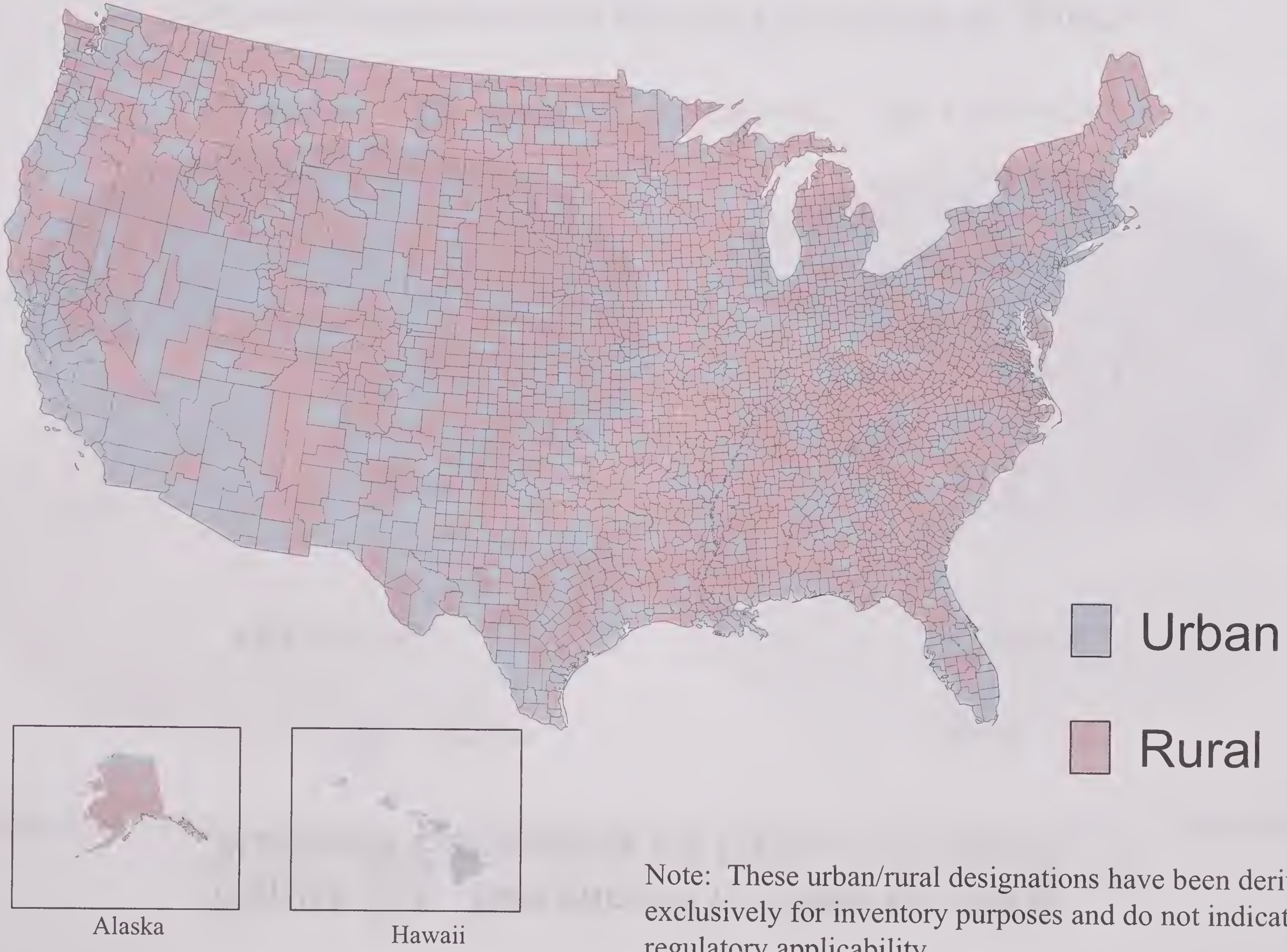
The estimates included in these tables have uncertainties and will improve/change as better data and estimation techniques become available over time.

Figure 7-1. 1996 NTI State Data Summary



Green - states who submitted HAP inventory data
X - states who submitted revisions by 9/1/99
* - local agencies who submitted revisions by 9/1/99

Figure 7-2. U.S. Counties by Urban and Rural Designation



Note: These urban/rural designations have been derived exclusively for inventory purposes and do not indicate regulatory applicability.

Figure 7-3. Baseline NTI (1990 to 1993) National Emissions by Urban vs. Rural

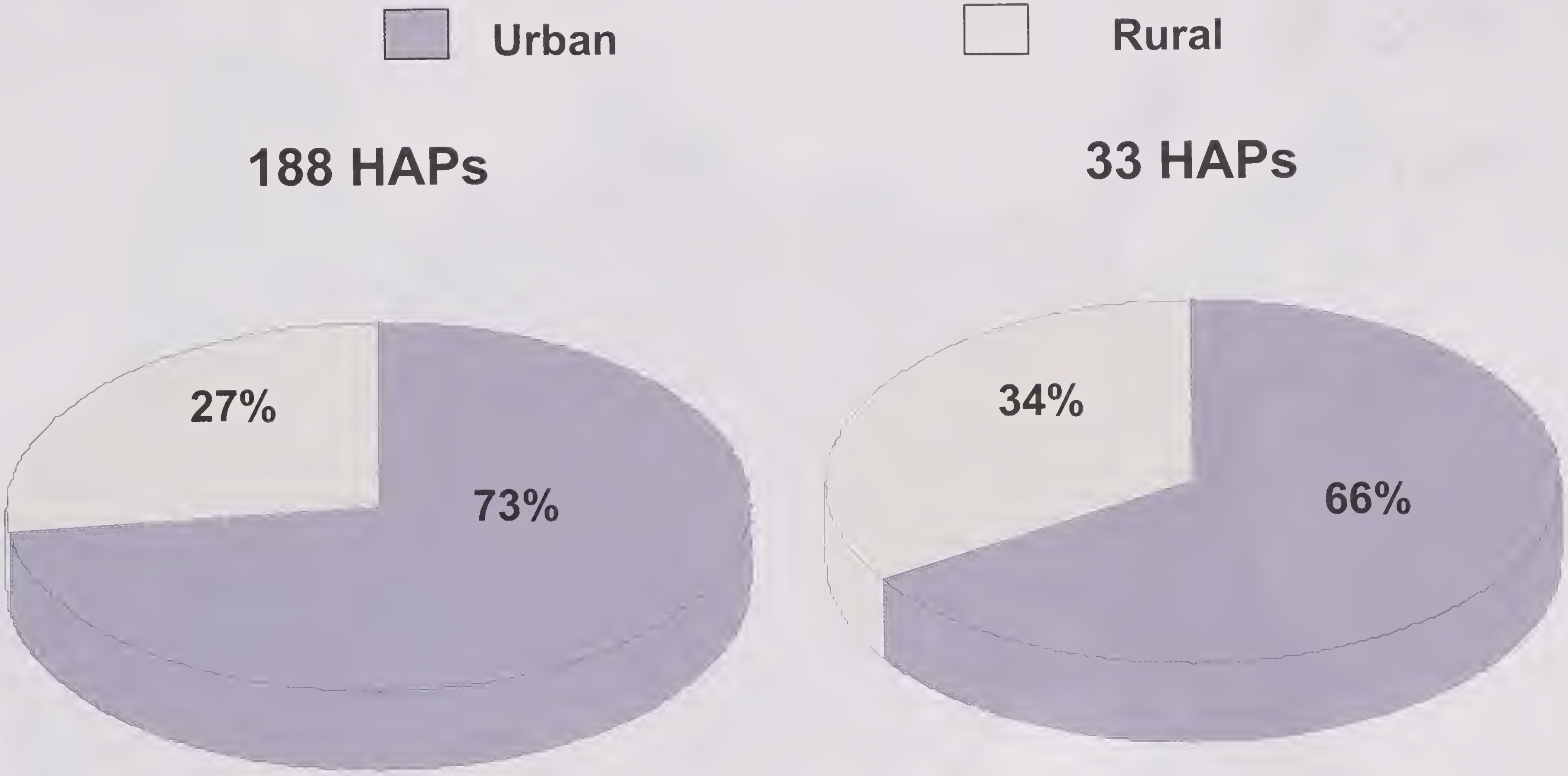
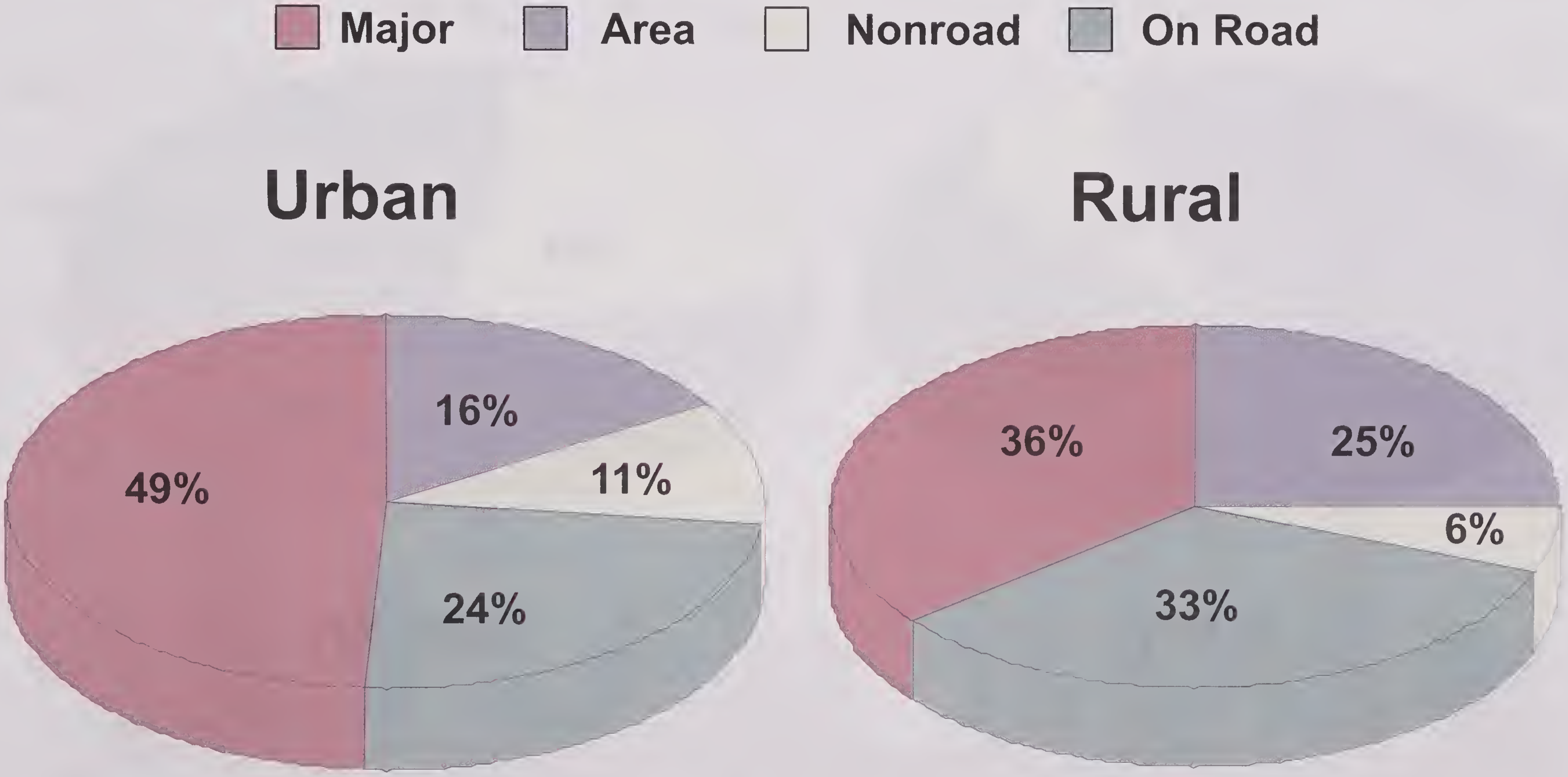


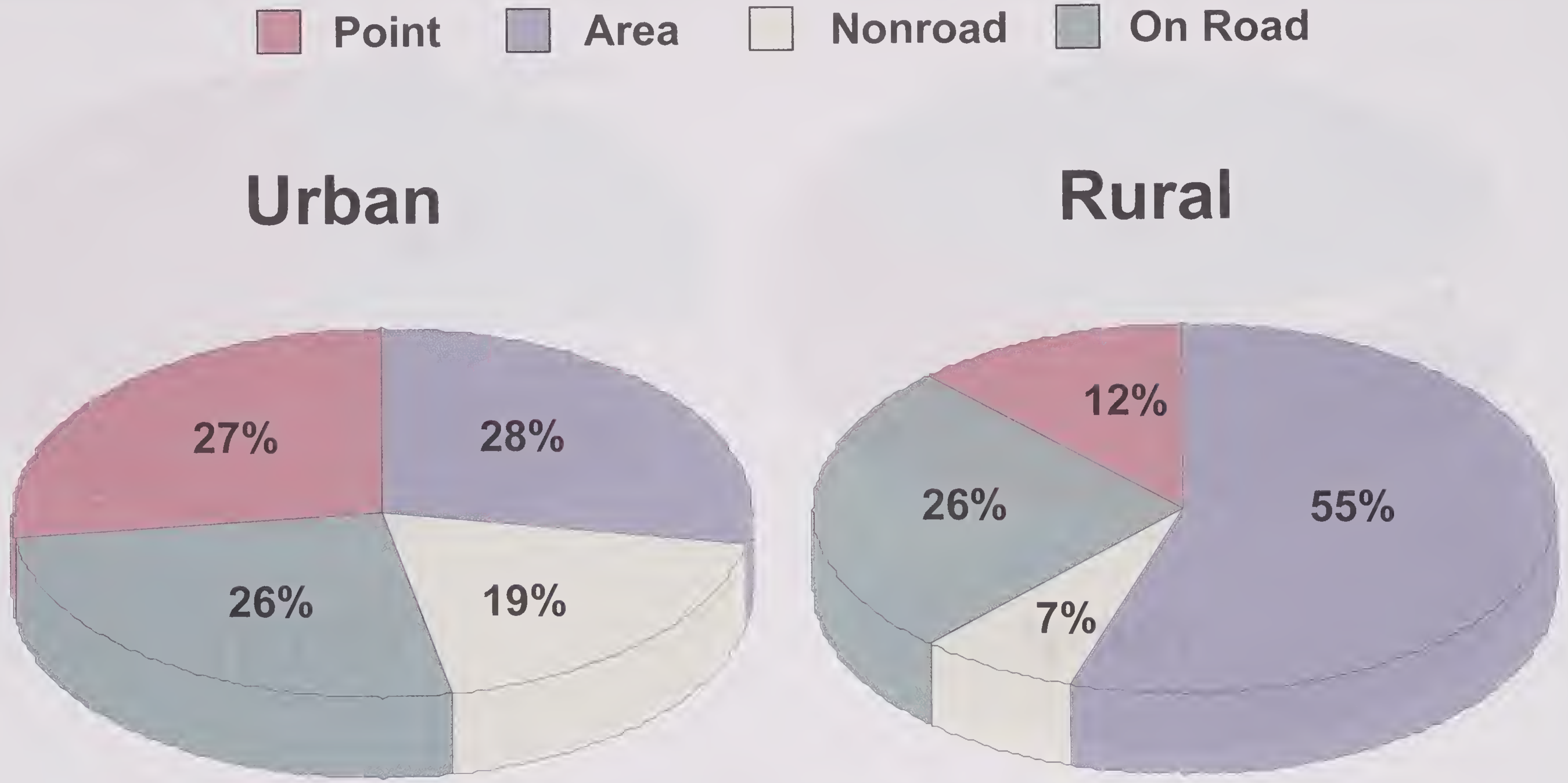
Figure 7-4. Baseline NTI (1990 to 1993) National Emissions of 188 HAPs by Urban vs. Rural



Total urban emissions are ~ 4,330,000 tons
73% of the total

Total rural emissions are ~ 1,580,000
27% of the total

Figure 7-5. Baseline NTI (1990 to 1993)
National Emissions of 33 HAPs by Urban vs. Rural



Total urban emissions are ~ 943,000 tons
66% of the total

Total rural emissions are ~ 480,000 tons
34% of the total

Figure 7-6. Baseline NTI (1990 to 1993) 188 HAP Emissions By State and Source Sector

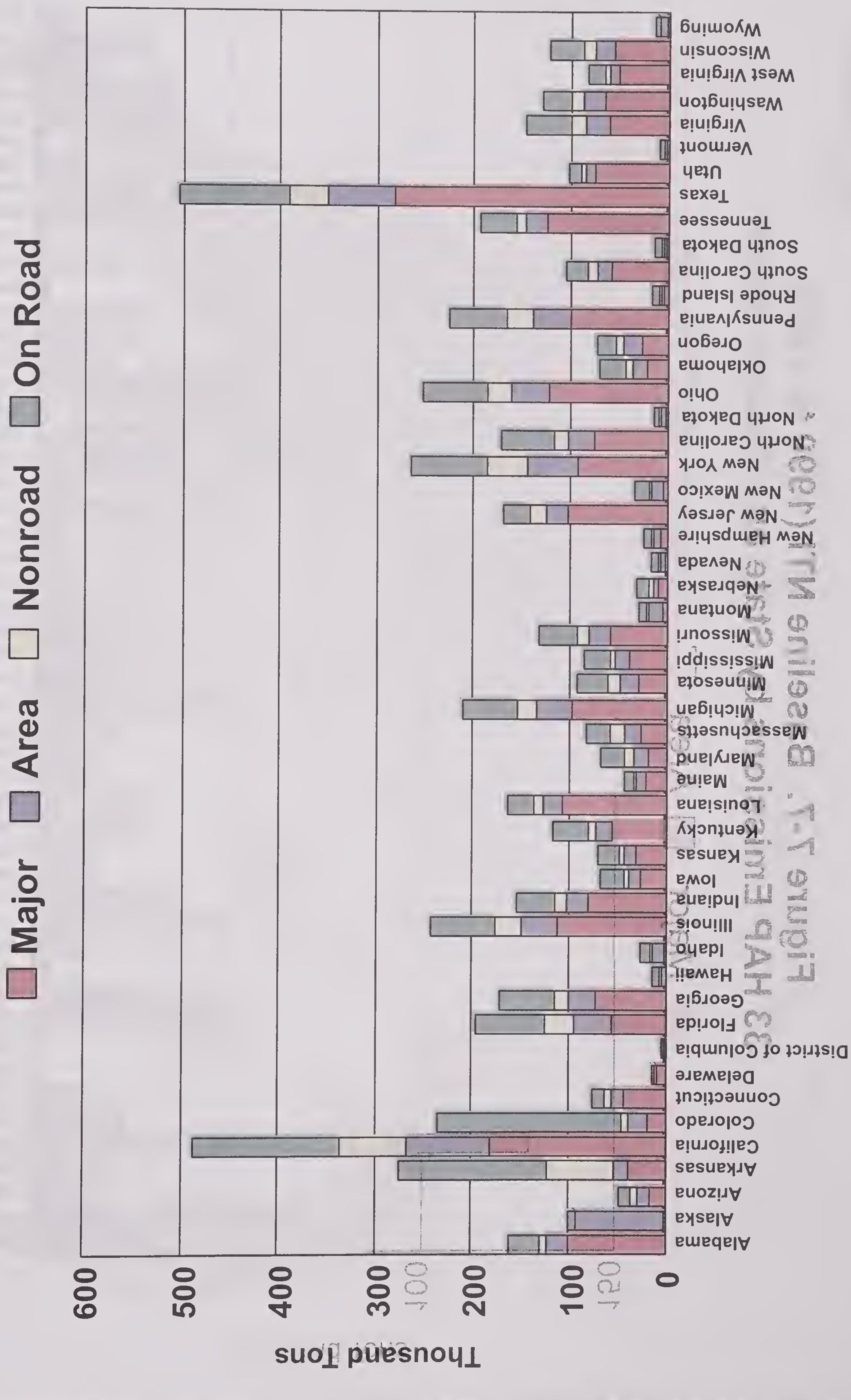


Figure 7-7. Baseline NTI (1990 to 1993) 33 HAP Emissions by State and Source Sector

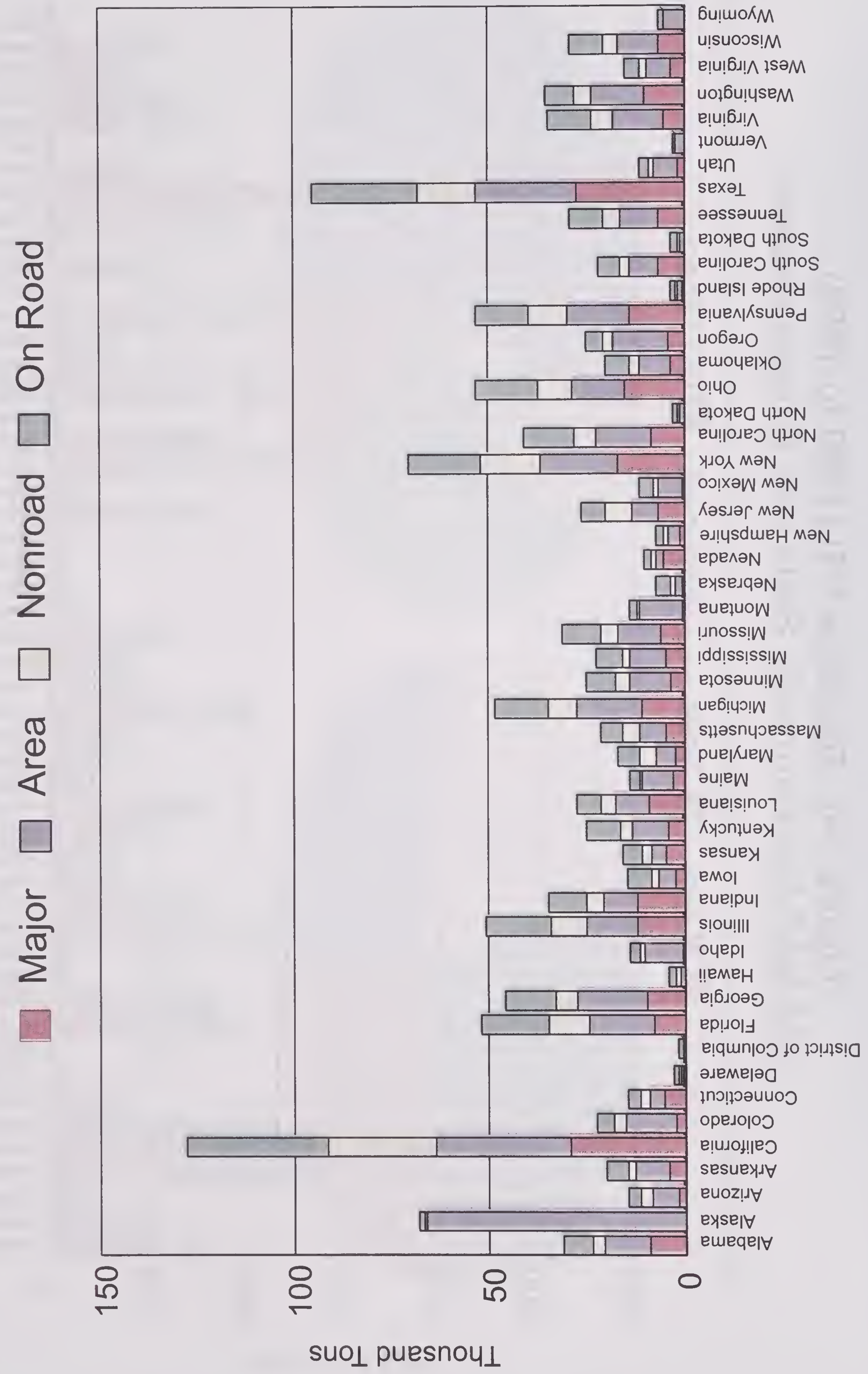
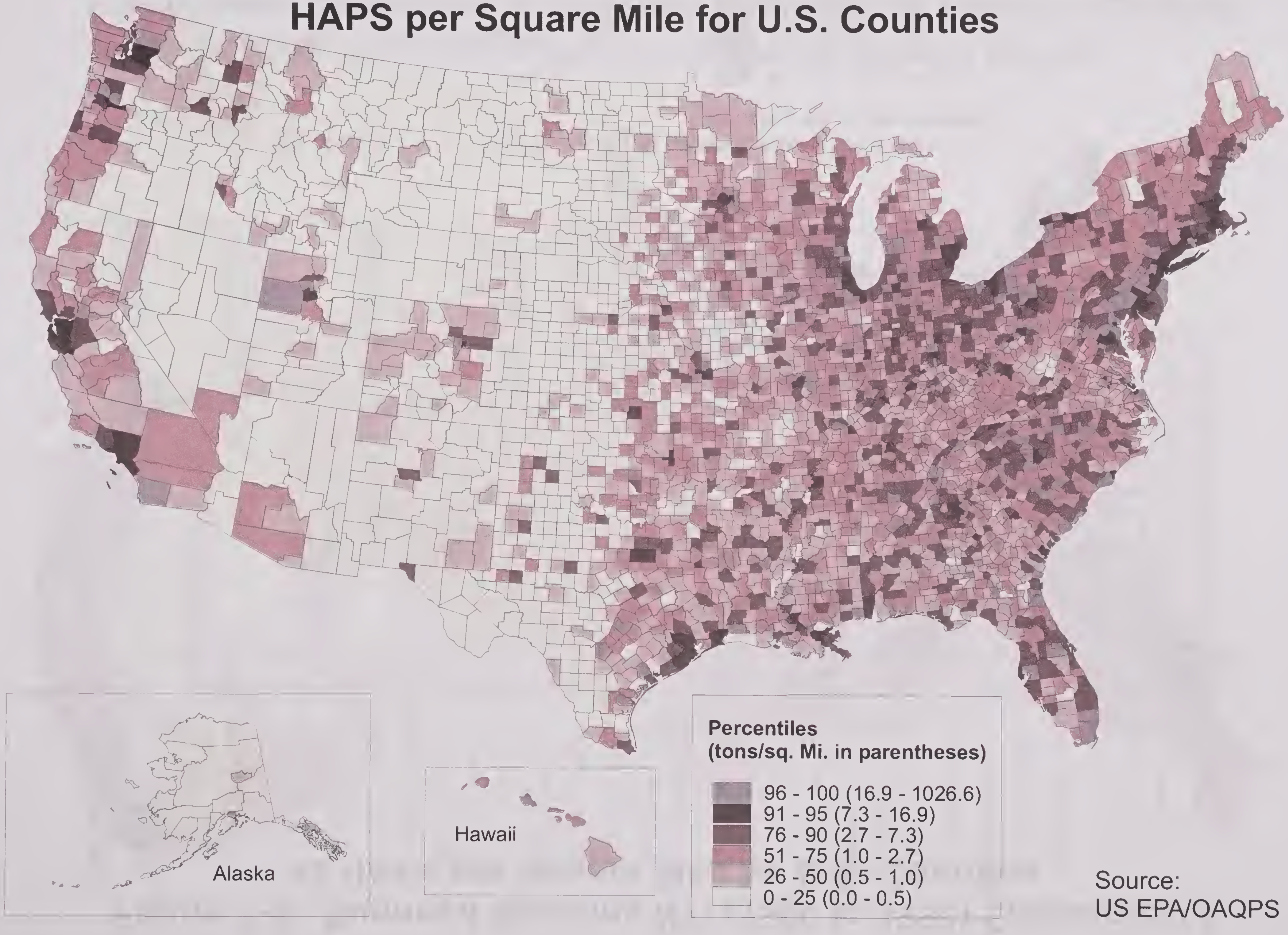
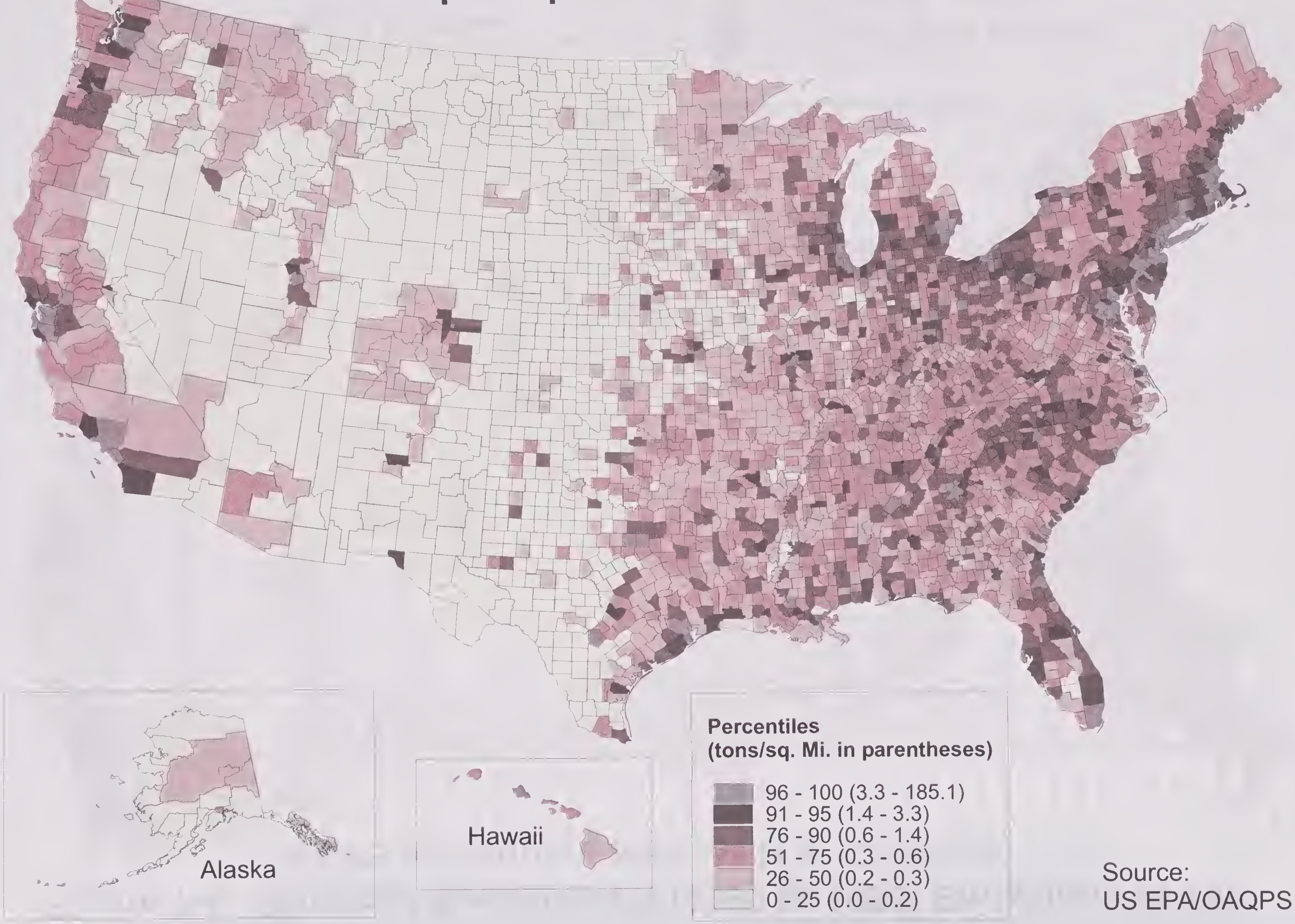


Figure 7-8. Summed Baseline NTI (1990 to 1993) Emissions of 188 HAPS per Square Mile for U.S. Counties


Alaska
Hawaii
Percentiles
(tons/sq. Mi. in parentheses)
96 - 100 (16.9 - 1026.6)
91 - 95 (7.3 - 16.9)
76 - 90 (2.7 - 7.3)
51 - 75 (1.0 - 2.7)
26 - 50 (0.5 - 1.0)
0 - 25 (0.0 - 0.5)

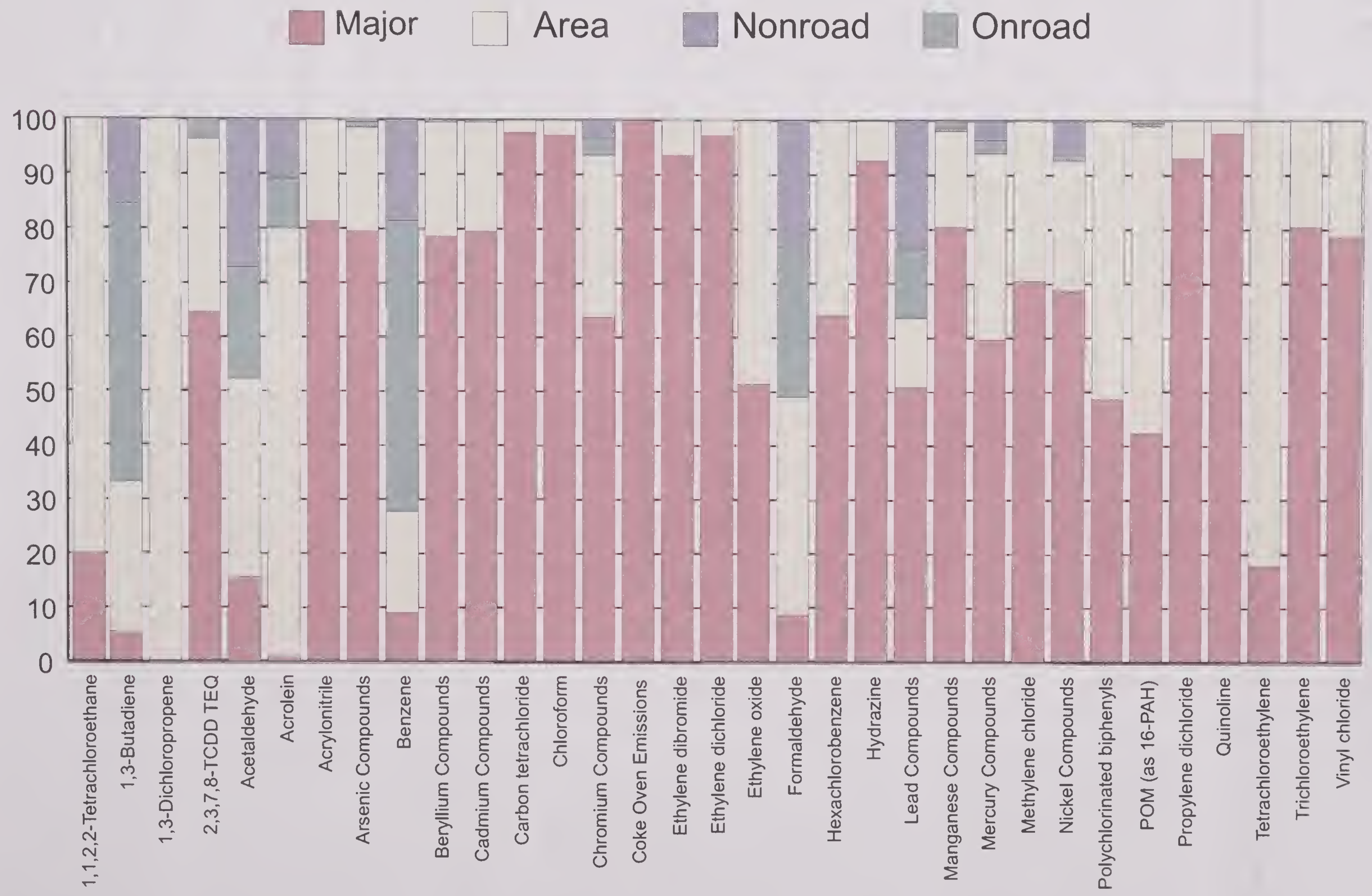
Source:
US EPA/OAQPS

Figure 7-9. Summed Baseline NTI (1990 to 1993) Emissions of 33 HAPs per Square Mile for U.S. Counties


Alaska
Hawaii
Percentiles
(tons/sq. Mi. in parentheses)
96 - 100 (3.3 - 185.1)
91 - 95 (1.4 - 3.3)
76 - 90 (0.6 - 1.4)
51 - 75 (0.3 - 0.6)
26 - 50 (0.2 - 0.3)
0 - 25 (0.0 - 0.2)

Source:
US EPA/OAQPS

Figure 7-10. Summary of Baseline NTI (1990 to 1993) of 33 HAPs National Emissions Percentage by Source Sector



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Chapter 8.0 National Greenhouse Gas Emissions

8.1 WHAT INFORMATION IS PRESENTED IN THIS CHAPTER?

This chapter summarizes the latest information on anthropogenic greenhouse gas emissions in the United States from 1990 through 1997. For a more detailed discussion, the reader is referred to the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1997*, April 1999, United States (U.S.) Environmental Protection Agency (EPA), EPA 236-R-99-003. This report is produced annually and submitted by the U.S. Government to the United Nations as part of our commitments under the Framework Convention on Climate Change (UNFCCC). Readers interested in the international efforts to address the problem of climate change through negotiation are referred to the home page of the UNFCCC at **http://www.unfccc.de**. Readers interested in more background on the science of climate change, global warming or greenhouse gases are referred to the Intergovernmental Panel on Climate Change (IPCC) via their website at **http://www.ipcc.ch**.

To ensure that the U.S. greenhouse gas emissions inventory meets the reporting requirements of the UNFCCC, the estimates were calculated using methodologies consistent with those recommended in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*[1]. For most source categories the IPCC default methodologies were expanded in order to incorporate emission factors and data specific to the United States, resulting in a more comprehensive and detailed estimate of U.S. emissions. (See Section 8.3.3.)

8.2 WHAT ARE THE RECENT TRENDS IN U.S. GREENHOUSE GAS EMISSIONS?

Naturally occurring greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). Several classes of halogenated substances that contain fluorine, chlorine, or bromine are also greenhouse gases, but they are, for the most part, solely a product of industrial activities. Chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) are halocarbons that contain chlorine, while halocarbons that contain bromine are referred to as halons. Other fluorine containing halogenated substances include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Total U.S. greenhouse gas emissions rose in 1997 to 1,813.6 million metric tons of carbon equivalents (MMTCE). The single year increase in emissions from 1996 to 1997 was 1.3 percent (23.1 MMTCE), down from the previous year's increase of 3.3 percent. Overall, emissions of greenhouse gases have increased 11 percent above 1990 levels. Table 8-1 provides a detailed summary of U.S. greenhouse gas emissions and sinks for 1990 through 1997.

In 1997, the primary greenhouse gas emitted by human activities was CO_2. The largest source of CO_2 and of overall greenhouse gas emissions in the United States was fossil fuel combustion. CH_4 emissions resulted primarily from decomposition of wastes in landfills, manure and enteric fermentation associated with domestic livestock, natural gas systems, and coal mining. Emissions of N_20 were dominated by agricultural soil management and mobile source fossil fuel combustion. The substitution of O_3 depleting substances and emissions of HFC-23 during the production of HCFC-22 were the primary contributors to aggregate HFC emissions. PFC emissions came mainly from primary aluminum production, while electrical transmission and distribution systems emitted the majority of SF_6.

As the largest source of U.S. greenhouse gas emissions, CO_2 from fossil fuel combustion accounted for 81 percent of emissions in 1997 when each gas is weighted by its Global Warming Potential (see Figure 8-1 in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1900-1997* for a discussion of global warming potentials). Emissions from fossil fuel combustion grew by 11 percent (138.8 MMTCE) over the 8-year period and were responsible for over three-quarters of the increase in national emissions. The annual increase in CO_2 emissions from this source was 1.3 percent in 1997, down from the previous year when emissions increased by 3.6 percent.

The dramatic increase in fossil fuel combustion related CO_2 emissions in 1996 was primarily a function of two factors: 1) fuel switching by electric utilities from natural gas to more carbon intensive coal as gas prices rose sharply due to weather conditions, which drove up residential consumption of natural gas for heating; and 2) higher petroleum consumption for transportation. In 1997, by comparison, electric utility natural gas consumption rose to regain much of the previous year's decline as the supply available rose due to lower residential consumption. Despite this increase in natural gas consumption by utilities and relatively stagnant U.S. electricity consumption, coal consumption rose in 1997 to offset the temporary shut-down of several nuclear power plants. Petroleum consumption for transportation activities in 1997 also grew by less than a percent, compared to almost 4 percent the previous year (see Table 8-2).

Overall, from 1990 to 1997, total emissions of CO_2, CH_4, and N_2O increased by 143.5 (11 percent), 9.7 (6 percent), and 13.4 MMTCE (14 percent), respectively. During the same period, weighted emissions of HFCs, PFCs, and SF_6 rose by 14.9 MMTCE (67 percent). Despite being emitted in smaller quantities, emissions of HFCs, PFCs, and SF_6 are significant because of their extremely high global warming potentials and, in the cases of PFCs and SF_6, long atmospheric lifetimes. Conversely, U.S. greenhouse gas emissions were partly offset by carbon sequestration in forests, which was estimated to be 11 percent of total emissions.

Other significant trends in emissions from other source categories over the 8-year period of 1990 through 1997 included:

- Aggregate HFC and PFC emissions resulting from the substitution of ozone depleting substances (e.g., CFCs) increased dramatically (by 14.4 MMTCE). This increase was partly offset, however, by reductions in PFC emissions from aluminum production (41 percent) and HFC emissions from HCFC-22 production (14 percent), both as a result of voluntary industry emission reduction efforts and, in the former case, from falling domestic aluminum production.

- Combined N_2O and CH_4 emissions from mobile source fossil fuel combustion rose 3.9 MMTCE (26 percent), primarily due to increased rates of N_2O generation in highway vehicles.

- CH_4 emissions from the decomposition of waste in municipal and industrial landfills rose by 10.5 MMTCE (19 percent) as the amount of organic matter in landfills steadily accumulated.

- Emissions from coal mining dropped by 5.2 MMTCE (21 percent) as the use of CH_4 from degasification systems increased significantly.

- N_2O emissions from agricultural soil management increased by 8.8 MMTCE (13 percent) as fertilizer consumption and cultivation of nitrogen fixing crops rose.

- An additional domestic adipic acid plant installed emission control systems in 1997, which was estimated to have resulted in a 1.4 MMTCE (27 percent) decline in emissions from 1996 to 1997 despite an increase in production.

8.3 WAS A MORE DETAILED ANALYSIS OF INDUSTRIAL EMISSIONS CONDUCTED?

Yes. An analysis of the industrial sector was conducted to provide greater resolution on the greenhouse gas emissions and energy consumption trends in the industrial end-use sector.

Figures 8-1 through 8-3 present CO_2 emissions data by industry end-use sector for the entire United States in the year 1994.

8.3.1 What Data Were Used in this Analysis?

This analysis was based on data contained in several EPA and Energy Information Administration (EIA) reports: the Manufacturing Consumption of Energy 1994, DOE/EIA-0512(94);[2] The Annual Energy Review 1997, DOE/EIA-0384(97);[3] Emissions of Greenhouse Gases in the United States 1997, DOE/EIA-0573(97);[4] and the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1996, EPA 236-R-98-006.[5]

The Annual Energy Review, EIA and the Emissions of Greenhouse Gases, EPA were used to develop national estimates of CO_2 for the year 1994. Both of these inventories report data on CO_2 emissions caused by both fuel combustion and industrial processes, and both were included in this analysis. Typically, fossil fuel combustion represents 81 percent of total U.S. greenhouse gas emissions and 99 percent of total U.S. CO_2 emissions, although there is some year-to-year variance. Cement manufacture is the largest remaining source of industrial CO_2 emissions, and has been estimated to contribute about 10 MMTCE to annual U.S. emissions. For more information on industrial sources of CO_2 or other greenhouse gas emission data, the reader is referred to the EPA inventory document or web site at **www.epa.gov/globalwarming/inventory**.

The Manufacturing Consumption of Energy (MECS) data were used to develop the detailed estimates for the industry sector. The MECS data are prepared once every 4 years, thus 1994 is presented as the most recent year for which the MECS data are available. The MECS data contain rich detail on manufacturing industries, but no information on the non-manufacturing industries, such as agricultural activity, mining, and construction. The MECS data were merged with estimates of total industrial energy use to develop these results. Emission estimates were developed using carbon coefficients for various fuel types, and for a quality assurance check, were compared with national inventory data. Refer to Annex A of the EPA Inventory document for more detail on carbon coefficients for fuel types. Table 8-3 presents the actual carbon coefficients used in this analysis.

8.3.2 What are the Results?

The results of this analysis show that the majority of CO_2 emissions can be attributed to a few major end-use sectors.

The utility sector, which represents 36 percent of total CO_2 emissions in 1994, supplies energy to industry. Emissions resulting from electricity production can thus be prorated to industry on the basis of electricity consumption. Ideally, this would be done on a regional basis in order to best capture the complexity of our nation's energy supply system and to account for variations in carbon emissions per kilowatt hour. However, this analysis uses national averages to develop the carbon emissions embedded in electricity consumption and attributes these emissions to the industries on the basis of their electricity demand.

Figure 8.1 shows total U.S. CO_2 emissions in 1994. Utilities contribute 36 percent of that total, with transportation the second largest sector at 30 percent of total CO_2 emissions. Emissions from utilities were estimated at 492 MMTCE in 1994, with 87 percent of that total resulting from coal consumption, 9 percent from natural gas, and 4 percent from petroleum fuel consumption.

Figure 8.2 presents all industrial emissions of CO_2 - both manufacturing and non-manufacturing - and the graph was developed to account for both "on-site" and "off-site" emissions. In this case, on-site emissions are process-related emissions such as CO_2 flux from lime calcination, and off-site emissions refer to the emissions that result from fossil fuel consumption at power plants supplying electricity to industry.

Figure 8.3 presents CO_2 emissions for the entire United States, and differs from Figure 8.1 in that utility sector has been "mapped" into the various end-use sectors that consume the electricity generated at utilities. Table 8.4 presents the CO_2 emissions data in tabular form.

8.3.3 What Methodologies were Utilized?

Emissions of greenhouse gases from various sources have been estimated using methodologies that are consistent with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*.[1] To the extent possible, the present U.S. inventory relies on published activity and emission factor data. Depending on the emission source category, *activity data* can include fuel consumption or deliveries, vehicle-miles traveled, raw material processed, etc.; *emission factors* are factors that relate quantities of emissions to an activity. For some sources, IPCC default methodologies and emission factors have been employed. However, for emission sources considered to be significant sources in the United States, the IPCC default methodologies were expanded and more comprehensive methods were applied. The Annexes of the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1997* contain additional detail and documentation on the calculations and assumptions used to obtain these estimates. This report can be found online at **www.epa.gov/globalwarming/inventory**.

Inventory emission estimates from energy consumption and production activities are based primarily on the latest official fuel consumption data from the EIA/DOE. CO_2 emissions from fuel combusted in ships or aircraft engaged in the international transport of passengers or cargo are not included in U.S. totals, but are reported separately as international bunkers in accordance with IPCC reporting guidelines.[1] CO_2 emissions from fuel combusted within U.S. territories, however, are included in U.S. totals.

Data on fuel consumption for the United States and its territories, carbon content of fuels, and percent of carbon sequestered in non-energy uses were obtained directly from the EIA/DOE. Fuel consumption data were obtained primarily from the *Monthly Energy Review*[6] and various EIA databases. U.S. marine bunker fuel consumption data for distillate and residual fuel oil was taken from *Fuel Oil and Kerosene Sales*.[7] Marine bunker fuel consumption in U.S. territories was collected from internal EIA databases[8] used to prepare the *International Energy Annual*.[9] Jet fuel consumption for aviation international bunkers was taken from *Fuel Cost and Consumption*,[10] which are monthly data releases by the Department of Transportation's Bureau of Transportation Statistics (DOT/BTS), and unpublished data from the Bureau of Economic Analysis (BEA).[11] The data collected by DOT/BTS includes fuel consumed for international commercial flights both originating and terminating in the United States. One-half of this value was assumed to have been purchased in the United States.[d]

IPCC[1] provided combustion efficiency rates for petroleum and natural gas. Bechtel[11] provided the combustion efficiency rates for coal. Vehicle type fuel consumption data for the allocation of transportation sector emissions were primarily taken from the *Transportation Energy Databook*[12] prepared by the Center for Transportation Analysis at Oak Ridge National Laboratory (DOE 1993, 1994, 1995, 1996, 1997, 1998). All jet fuel and aviation gasoline were assumed to have been consumed in aircraft.

8.4 REFERENCES

1. "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories," Paris: Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. 1997.
2. "Manufacturing Consumption of Energy 1994," DOE/EIA-0512(94), Energy Information Administration, U.S. Department of Energy, Washingotn, DC. 1994.
3. "Annual Energy Review 1997," DOE/EIA- 0384(97)-annual, Energy Information Administration, U.S. Department of Energy, Washington, DC. July 1998.
4. "Emissions of Greenhouse Gases in the United States 1997," DOE/EIA-0573(97), Energy Information Administration, U.S. Department of Energy, Washington, DC. 1997.
5. "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1997," EPA 236-R-99-003, U.S. Environmental Protection Agency. April 1999.
6. "Monthly Energy Review," DOE/EIA- 0035(98)-monthly, Energy Information Administration, U.S. Department of Energy, Washington, DC. July 1998.
7. "Fuel Oil and Kerosene Sales 1997," DOE/EIA-0535(97)-annual, Energy Information Administration, U.S. Department of Energy, Washington, DC. 1998.
8. "Report of Bunker Fuel Oil Laden on Vessels Cleared for Foreign Countries," unpublished, Form-563, Foreign Trade Division, Bureau of the Census, U.S. Department of Commerce. 1998.
9. "International Energy Annual 1996," DOE/EIA-0219(96)-annual, Energy Information Administration, U.S. Department of Energy, Washington, DC. 1998.
10. "Fuel Cost and Consumption," monthly reports, DAI-10, Federal Aviation Administration, U.S. BTS, Department of Transportation, Washington, DC. 1998.
11. "Survey of Current Business," Bureau of Economic Analysis, Department of Commerce, Table 2A, p. 152, August 1998. **http://www.bea.doc.gov/bea.dn1.htm**
12. DOE (1993-1998) "Transportation Energy Databook," (1993-1998), prepared by the Center for Transportation Analysis at Oak Ridge National Laboratory for the Department of Energy, Oak Ridge, IL.

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d. See section titled International Bunker Fuels for a more detailed discussion.

Table 8-1. Recent Trends in U.S. Greenhouse Gas Emissions and Sinks (MMTCE)

Gas/Source	1990	1991	1992	1993	1994	1995	1996	1997
CO_2	**1,344.3**	**1,329.8**	**1,349.6**	**1,379.2**	**1,403.5**	**1,419.2**	**1,469.3**	**1,487.9**
Fossil Fuel Combustion	1,327.2	1,312.6	1,332.4	1,360.6	1,383.9	1,397.8	1,447.7	1,466.0
Natural Gas Flaring	2.3	2.6	2.6	3.5	3.6	4.5	4.3	4.2
Cement Manufacture	8.9	8.7	8.8	9.3	9.6	9.9	9.9	10.2
Lime Manufacture	3.3	3.2	3.3	3.4	3.5	3.7	3.8	3.9
Limestone and Dolomite Use	1.4	1.3	1.2	1.1	1.5	1.9	2.0	2.1
Soda Ash Manufacture and Consumption	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2
Carbon Dioxide Consumption	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
Land-Use Change and Forestry (Sink)[a]	(311.5)	(311.5)	(311.5)	(208.6)	(208.6)	(208.6)	(208.6)	(208.6)
International Bunker Fuels[b]	27.1	27.8	29.0	29.9	27.4	25.4	25.4	26.6
CH_4	**169.9**	**171.0**	**172.5**	**172.0**	**175.5**	**178.6**	**178.3**	**179.6**
Stationary Sources	2.3	2.4	2.4	2.4	2.4	2.5	2.5	2.2
Mobile Sources	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Coal Mining	24.0	22.8	22.0	19.2	19.4	20.3	18.9	18.8
Natural Gas Systems	32.9	33.3	33.9	34.1	33.5	33.2	33.7	33.5
Petroleum Systems	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.6
Petrochemical Production	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Silicon Carbide Production	+	+	+	+	+	+	+	+
Enteric Fermentation	32.7	32.8	33.2	33.6	34.5	34.9	34.5	34.1
Manure Management	14.9	15.4	16.0	16.1	16.7	16.9	16.6	17.0
Rice Cultivation	2.5	2.5	2.8	2.5	3.0	2.8	2.5	2.7
Agricultural Residue Burning	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Landfills	56.2	57.6	57.8	59.7	61.6	63.6	65.1	66.7
Wastewater Treatment	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
International Bunker Fuels[b]	+	+	+	+	+	+	+	+
N_2O	**95.7**	**97.6**	**100.1**	**100.4**	**108.3**	**105.4**	**108.2**	**109.0**
Stationary Sources	3.8	3.8	3.9	3.9	4.0	4.0	4.1	4.1
Mobile Sources	13.6	14.2	15.2	15.9	16.7	17.0	17.4	17.5
Adipic Acid	4.7	4.9	4.6	4.9	5.2	5.2	5.4	3.9
Nitric Acid	3.3	3.3	3.4	3.5	3.7	3.7	3.9	3.8
Manure Management	2.6	2.8	2.8	2.9	2.9	2.9	3.0	3.0
Agricultural Soil Management	65.3	66.2	68.0	67.0	73.4	70.2	72.0	74.1
Agricultural Residue Burning	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Human Sewage	2.1	2.1	2.2	2.2	2.2	2.3	2.3	2.3
Waste Combustion	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
International Bunker Fuels[b]	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2
HFCs, PFCs, and SF_6	**22.2**	**21.6**	**23.0**	**23.4**	**25.9**	**30.8**	**34.7**	**37.1**
Substitution of Ozone Depleting Substances	0.3	0.2	0.4	1.4	4.0	9.5	11.9	14.7
Aluminum Production	4.9	4.7	4.1	3.5	2.8	2.7	2.9	2.9
HCFC-22 Production	9.5	8.4	9.5	8.7	8.6	7.4	8.5	8.2
Semiconductor Manufacture	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.3
Electrical Transmission and Distribution	5.6	5.9	6.2	6.4	6.7	7.0	7.0	7.0
Magnesium Production and Processing	1.7	2.0	2.2	2.5	2.7	3.0	3.0	3.0
Total Emissions	**1,632.1**	**1,620.0**	**1,645.2**	**1,675.0**	**1,713.2**	**1,733.9**	**1,790.5**	**1,813.6**
Net Emissions (Sources and Sinks)	**1,320.6**	**1,308.5**	**1,333.7**	**1,466.5**	**1,504.7**	**1,525.4**	**1,582.0**	**1,605.0**

+ Does not exceed 0.05 MMTCE

[a] Sinks are only included in net emissions total. Estimates of net carbon sequestration due to land-use change and forestry activities exclude non-forest soils, and are based partially upon projections of forest carbon stocks.

[b] Emissions from International Bunker Fuels are not included in totals.

Note: Totals may not sum due to independent rounding.

Table 8-2. Annual Percent Change in CO_2 Emissions from Fossil Fuel Combustion for Selected Sectors and Fuels

Sector	Fuel Type	1995 to 1996	1996 to 1997
Electric Utility	Coal	5.7%	2.9%
Electric Utility	Natural Gas	-14.6%	8.7%
Residential	Natural Gas	8.1%	-4.4%
Transportation*	Petroleum	3.4%	0.3%

* Excludes emissions from International Bunker Fuels

Table 8-3. Carbon Coefficients, MMTCE/QBtu (Q=E15)

Year	Electricity	Residual Oil	Distillate Oil	NG	LPG	Coal	Coke	Still Gas
1994	50	21.49	19.95	14	17.01	25	25	20.19
1995	50	21.49	19.95	14	16.99	25	25	20.23

Table 8-4. Carbon Dioxide Emissions in the U.S., 1994 (MMTCE)

Sector/Source Category	Electricity	Petroleum	NG	Coal	Still Gas, Coke, Other	Process CO_2	Total	% of Industrial CO_2 Emissions	% of Total CO_2 Emissions	% of Total Greenhouse Gas Emissions
Agriculture	9.6	14.0	0.0	0.0	0.0	0.0	23.6	5%	2%	1%
Mining & construction	17.2	15.4	42.8	13.4	0.0	0.0	88.7	18%	6%	5%
Food Products	9.9	1.1	8.8	4.1	2.7	0.0	26.6	5%	2%	2%
Tobacco Products	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0%	0%	0%
Textile Products	5.6	0.4	1.6	1.0	0.3	0.0	9.1	2%	1%	1%
Apparel	1.3	0.0	0.3	0.0	0.0	0.0	1.8	0%	0%	0%
Lumber & wood	3.4	0.4	0.7	0.0	1.2	0.0	5.9	1%	0%	0%
Furniture & fixtures	1.1	0.0	0.3	0.1	0.3	0.0	1.8	0%	0%	0%
Paper	11.2	3.9	8.0	7.6	0.0	0.0	30.7	6%	2%	2%
Printing	3.0	0.0	0.7	0.0	0.0	0.0	3.8	1%	0%	0%
Chemicals	30.1	1.5	26.4	6.4	8.8	0.0	73.3	15%	5%	4%
Petroleum-Refining	10.2	2.7	0.0	0.0	41.9	0.0	73.3	15%	5%	4%
Rubber	7.5	0.3	1.5	0.1	0.1	0.0	9.5	2%	1%	1%
Leather	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0%	0%	0%
Stone, clay & glass	6.2	0.7	6.0	6.8	1.7	16.0	37.3	8%	3%	2%
Primary metal	28.8	1.2	11.2	1.3	24.8	0.0	67.3	14%	5%	4%
Fabricated metal	5.8	0.2	3.1	0.0	0.0	0.0	9.5	2%	1%	1%
Industrial machinery	5.5	0.1	1.5	0.3	0.1	0.0	7.6	2%	1%	0%
Electronic equip	5.7	0.1	1.2	0.0	0.0	0.0	7.8	2%	1%	0%
Transportation equip	6.6	0.4	2.1	0.7	0.4	0.0	10.4	2%	1%	1%
Instruments	2.3	0.1	0.0	0.6	0.0	0.0	4.3	1%	0%	0%
Misc manufacturing	1.0	0.0	0.3	0.0	0.0	0.0	1.6	0%	0%	0%
Industry Total	172.0	43.4	128.3	43.1	83.4	16.0	486.2	102%	35%	28%
Transportation	0.0	411.2	10.2	0.0	0.0	0.0	422.1		30%	25%
Commercial	153.0	14.9	42.9	2.1	0.0	0.0	214.1		15%	12%
Residential	166.9	25.3	71.8	1.4	0.0	0.0	268.6		19%	16%
Territories	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0%	0%
Total	491.9	506.0	253.2	46.6	83.4	16.0	1405.0		100%	82%

Figure 8-1. U.S. Carbon Dioxide Emissions by Sector (1994)

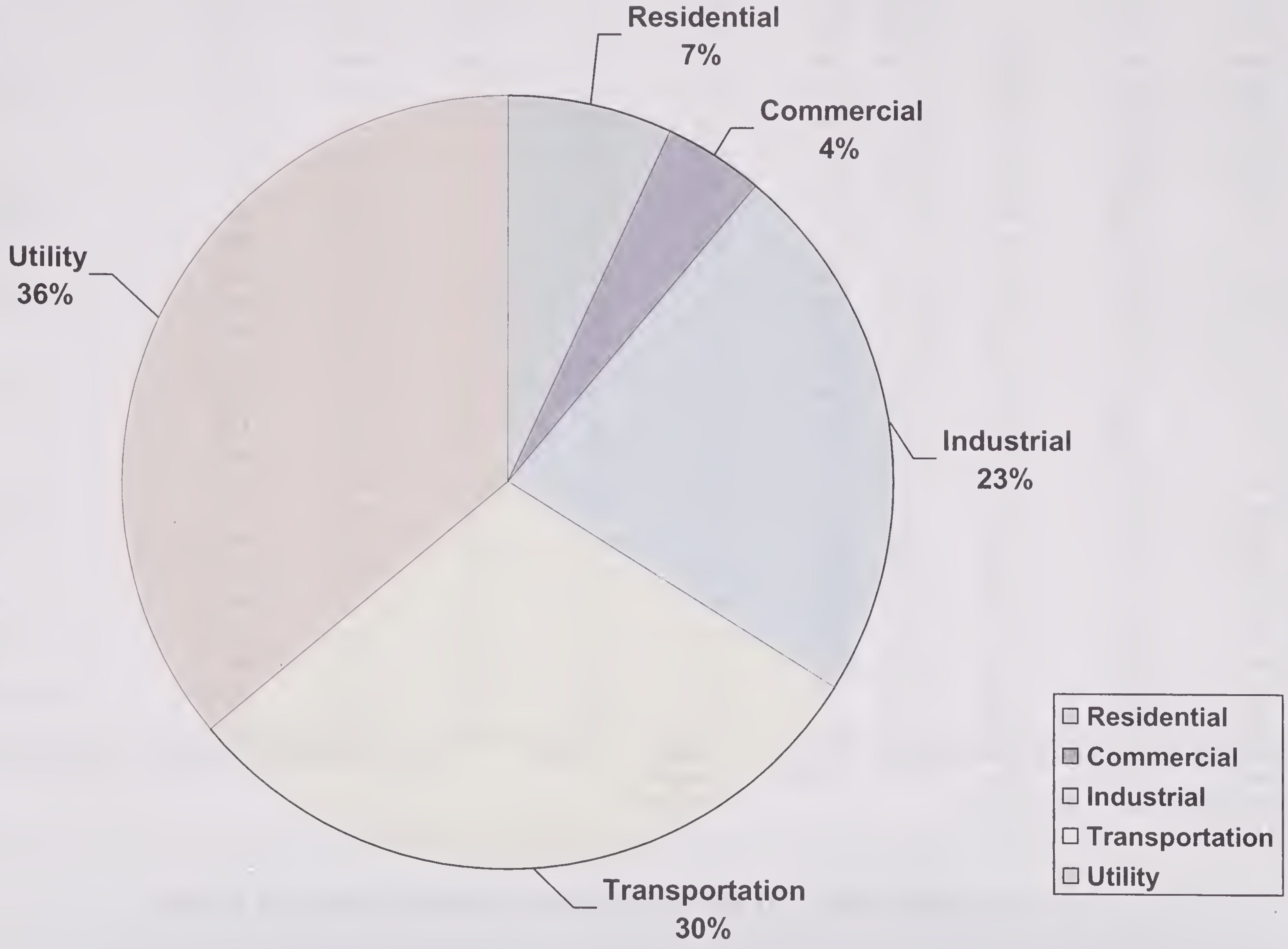


Figure 8-2. Carbon Dioxide Emissions from Industry (1994)

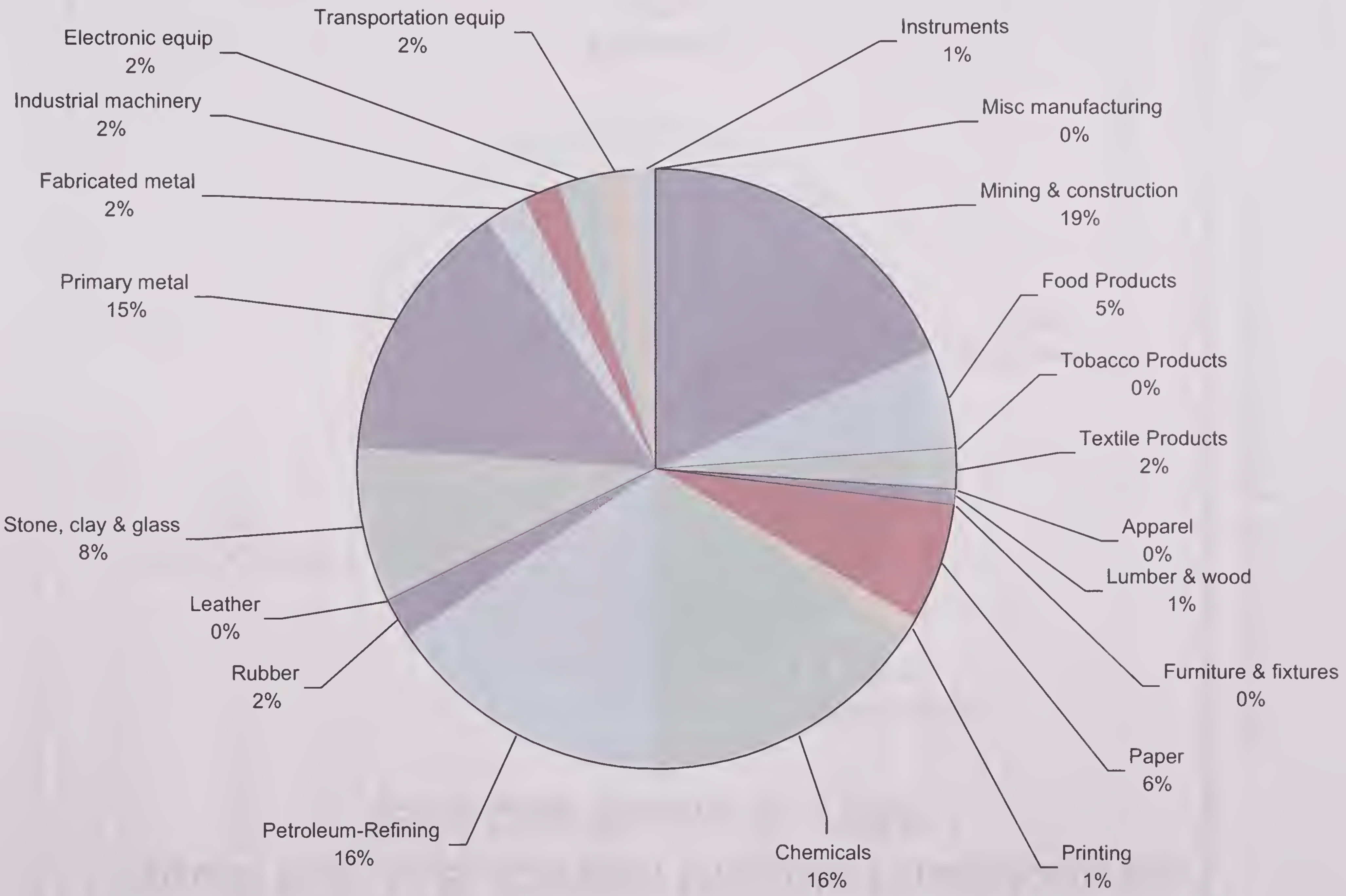
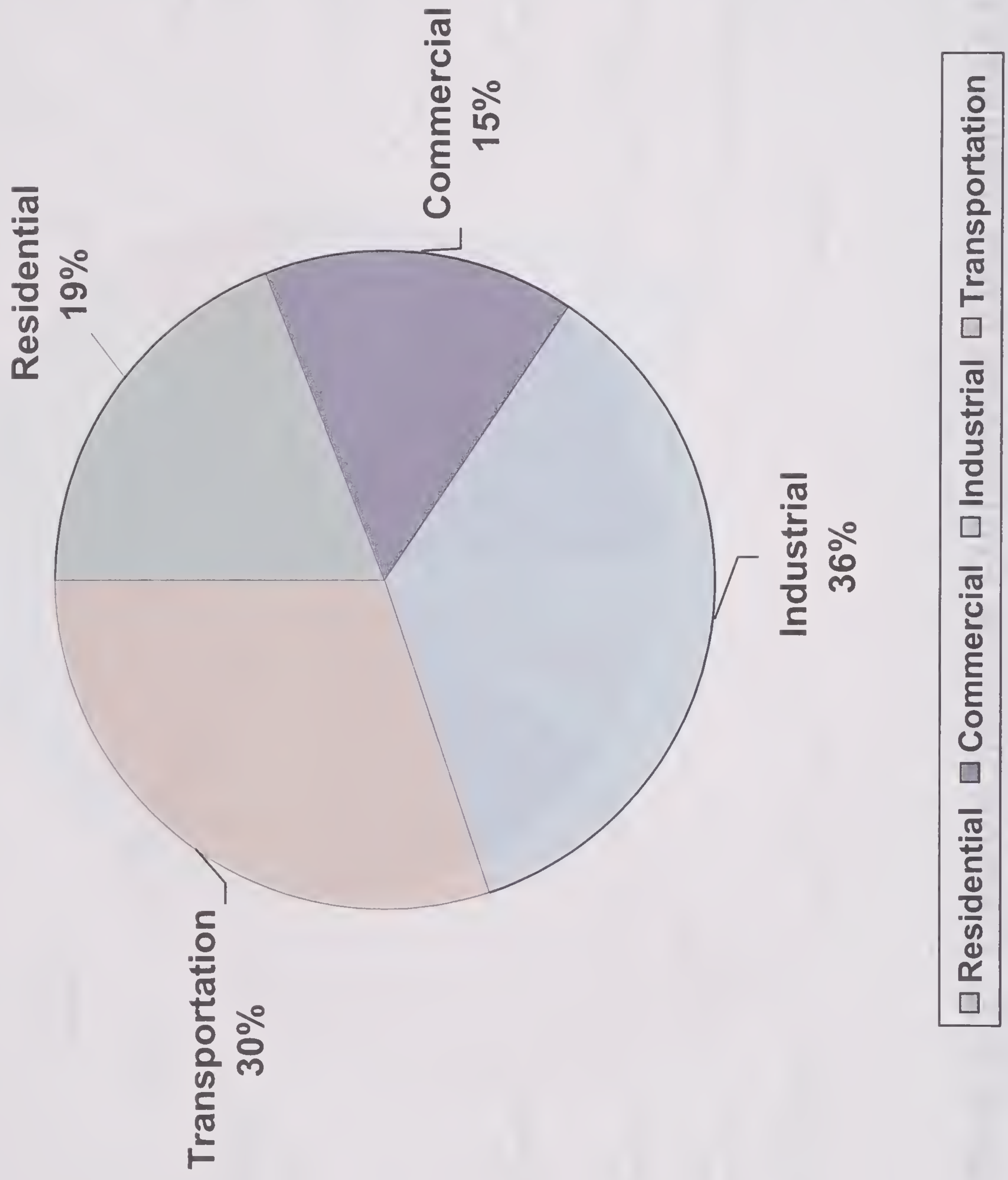


Figure 8-3. U.S. Carbon Dioxide Emissions by End-Use Sector in 1994



Chapter 9.0 International Emissions

9.1 WHAT DATA ARE PRESENTED IN THIS CHAPTER?

This chapter presents the 1996 European emission estimates for the pollutants carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), nonmethane volatile organic compounds (NMVOCs), methane (CH_4), carbon dioxide (CO_2), nitrous oxide (N_2O), and ammonia (NH_3), and the 1995 Canadian emission estimates for the pollutants CO, NO_x, volatile organic compounds (VOC), SO_2, total particulate (TP), particulate matter (PM) less than 10 microns in diameter (PM_{10}), and PM less than 2.5 microns in diameter ($PM_{2.5}$).

9.2 WHAT EUROPEAN EMISSIONS ARE PRESENTED?

In 1993, the European Union launched the European Environment Agency (EEA) with a mandate to orchestrate, cross-check, and put to strategic use information relevant to protecting and improving Europe's environment.[1] CORINAIR (Coordination of Environmental Air) is the air emission inventory for Europe The CORINAIR project is part of the work program of the EEA. The EEA designated the European Topic Center on Air Emissions (ETC/AEM) to perform the CORINAIR project by assisting participating countries to report their national inventories as required under international obligations. Based on these reports the ETC/AEM prepares the European air emission inventory and database.[2]

The countries that submitted 1996 data on emissions of ozone precursors and acidifying pollutants to CORINAIR include Austria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Luxembourg, the Netherlands, Norway, Slovenia, and the United Kingdom. In addition, the following countries submitted 1996 data on emissions of greenhouse gases to the United Nations Framework Convention on Climate Change (UNFCCC): Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Luxembourg, the Netherlands, Norway, Slovenia, Spain, Sweden, and the United Kingdom.

Table 9-1 shows European national total emissions for 1996 for the following pollutants: SO_2, NO_x, NMVOC, CH_4, CO, CO_2, and NH_3. Tables 9-2 through 9-8 present 1996 country-level summary data by CORINAIR/EMEP (Cooperative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe) source category for SO_2, NO_x, NMVOC, CO, and NH_3. The CORINAIR/EMEP source categories include:

- Combustion in energy and transformation industries
- Nonindustrial combustion plants
- Combustion in manufacturing industry
- Production processes
- Extraction and distribution of fossil fuels/geothermal energy
- Solvent and other product use
- Road transport
- Other mobile sources and machinery
- Waste treatment and disposal
- Agriculture and forestry, land use and woodstock change
- Nature

Because some countries included estimates of NMVOC and CO_2 emissions in the Nature and the Agriculture categories, these tables include a "Comparable Total" line, omitting these two categories for each country.

Tables 9-9 to 9-13 present 1996 country-level summary data by EEA source category for CH_4, CO_2, and N_2O. The EEA source categories include Energy, Industry, Transport, Agriculture, Waste, and Other.

9.3 WHAT CANADIAN EMISSIONS ARE PRESENTED?

The criteria air pollutant annual emissions data for Canada were provided by Environment Canada[3] for 1995. Emissions were provided for CO, NO_x, VOC, SO_2, TP, PM_{10}, and $PM_{2.5}$. Table 9-14 presents the emission estimates for Canada by major source category. Table 9-15 presents the emissions for Canada by Province.

9.4 REFERENCES

1. European Environment Agency, at **http://org.eea.eu.int/**. January 2000.
2. "ETC/Air Emissions" (Database version 2.2, 10/25/99), at **http://warehouse.eea.eu.int/**, European Topic Centre on Air Emissions, European Environment Agency, Copenhagen, Denmark. October 1999.
3. Environment Canada, at **http://www.ec.gc.ca**. August 1999.
4. "Population for the Countries of the World: 1996," at **gopher://gopher.undp.org**, United Nations Population Division. August 1999.
5. "World Emissions Tables," at **http://projects.dnmi.no/%7emep/emis_tables/**, Meteorological Synthesizing Centre-West, EMEP. July 1999.

Table 9-1. 1996 Emission Estimates for Europe by Country and Pollutant (thousand short tons; except CO_2 [million short tons])

Country	Population (million)	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	NH_3
Armenia	3.6	2	12	20	NA	138	NA	0
Austria	8.1	57	180	288	493	1,125	NA	84
Belarus	10.3	271	191	362	NA	1,339	NA	4
Belgium	10.1	265	368	357	NA	1,369	NA	107
Bulgaria	8.4	1,565	285	162	546	676	NA	91
Croatia	4.5	64	74	87	148	413	20	25
Cyprus	0.8	51	23	NA	NA	NA	7	NA
Czech Republic	10.2	1,043	476	313	632	977	142	89
Denmark	5.2	205	317	150	468	658	80	109
Finland	5.1	116	294	191	281	474	73	39
France	58.3	1,136	1,809	2,833	3,142	9,755	366	736
Germany	81.9	1,701	2,080	2,069	3,939	7,404	1,013	715
Greece	10.4	599	412	451	504	1,470	101	NA
Hungary	10.0	742	216	165	NA	801	74	86
Ireland	3.6	162	133	114	811	338	40	141
Latvia	2.5	65	39	45	103	194	12	NA
Lithuania	3.7	103	72	96	314	344	21	40
Luxembourg	0.4	9	24	20	25	114	8	8
Netherlands	15.6	149	552	399	1,359	995	209	161
Norway	4.3	37	246	407	535	794	45	29
Poland	38.6	2,610	1,272	844	2,016	5,332	NA	408
Russian Federation	148.1	2,960	2,719	2,840	3,457	10,265	1,653	826
Slovakia	5.3	250	143	116	330	381	50	55
Slovenia	1.9	121	77	NA	NA	105	17	NA
Sweden	8.8	91	333	492	327	1,193	69	67
Switzerland	7.2	33	143	224	259	535	NA	78
Ukraine	51.6	1,425	515	791	NA	2,830	NA	NA
United Kingdom	58.1	2,223	2,237	2,255	4,094	5,511	654	352
Yugoslavia	10.3	478	63	NA	NA	NA	NA	NA
Total	586.9	18,533	15,305	16,091	23,783	55,530	4,654	4,250

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source of population data: United Nations Population Division[4]
Source of emission data: EMEP, Meteorological Synthesizing Centre-West[5]

Table 9-2. 1996 Emission Estimates for Austria and the Czech Republic by CORINAIR/EMEP Source Category and Pollutant

(thousand short tons)

Austria	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	9	11	0	1	0
Nonindustrial combustion plants	18	22	46	478	1
Combustion in manufacturing industry	10	17	1	6	0
Production processes	15	21	25	291	0
Extraction and distribution of fossil fuels/geothermal energy	1	0	4	0	0
Solvent and other product use	0	0	147	0	0
Road transport	3	93	58	335	3
Other mobile sources and machinery	0	8	3	8	0
Waste treatment and disposal	0	0	1	5	0
Agriculture and forestry, land use and woodstock change	0	7	3	2	80
Nature	0	1	181	0	1
Total	57	180	469	1,126	85
Comparable Total	57	178	285	1,126	84

Czech Republic	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	715	131	5	17	0
Nonindustrial combustion plants	186	49	48	366	0
Combustion in manufacturing industry	130	45	10	271	0
Production processes	2	1	31	1	2
Extraction and distribution of fossil fuels/geothermal energy	0	0	3	0	0
Solvent and other product use	0	0	131	0	0
Road transport	6	191	72	263	1
Other mobile sources and machinery	3	59	13	59	0
Waste treatment and disposal	0	1	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	0	0	87
Nature	0	0	45	0	1
Total	1,043	476	358	977	90
Comparable Total	1,043	476	313	977	89

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding. Negative emissions represent a sink for greenhouse gas.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-3. 1996 Emission Estimates for Denmark and Finland by CORINAIR/EMEP Source Category and Pollutant

(thousand short tons)

Denmark	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	160	142	2	12	0
Nonindustrial combustion plants	13	8	13	133	0
Combustion in manufacturing industry	13	16	1	7	0
Production processes	3	1	12	0	0
Extraction and distribution of fossil fuels/geothermal energy	0	0	8	48	0
Solvent and other product use	0	0	23	0	0
Road transport	2	87	67	391	1
Other mobile sources and machinery	8	62	13	66	0
Waste treatment and disposal	0	2	1	1	0
Agriculture and forestry, land use and woodstock change	0	0	1	0	108
Nature	0	0	10	0	0
Total	198	318	150	659	109
Comparable Total	198	318	139	659	109

Finland	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	48	48	0	8	0
Nonindustrial combustion plants	15	15	35	73	0
Combustion in manufacturing industry	27	36	0	47	0
Production processes	23	8	12	11	1
Extraction and distribution of fossil fuels/geothermal energy	0	0	10	0	0
Solvent and other product use	0	0	35	0	0
Road transport	1	189	75	331	0
Other mobile sources and machinery	2	0	20	3	0
Waste treatment and disposal	0	0	2	0	0
Agriculture and forestry, land use and woodstock change	0	0	0	0	37
Nature	0	0	0	0	0
Total	116	297	190	473	39
Comparable Total	116	297	190	473	39

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-4. 1996 Emission Estimates for France and Germany by CORINAIR/EMEP Source Category and Pollutant

(thousand short tons)

France	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	394	140	4	18	0
Nonindustrial combustion plants	95	118	237	2,044	0
Combustion in manufacturing industry	295	170	12	615	0
Production processes	80	19	95	638	31
Extraction and distribution of fossil fuels/geothermal energy	15	0	110	0	0
Solvent and other product use	0	0	634	0	0
Road transport	129	988	985	4,980	8
Other mobile sources and machinery	18	410	158	466	0
Waste treatment and disposal	18	25	31	256	4
Agriculture and forestry, land use and woodstock change	0	0	20	0	848
Nature	0	3	413	84	0
Total	1,044	1,873	2,700	9,100	891
Comparable Total	1,044	1,870	2,266	9,017	891

Germany	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	931	377	8	129	3
Nonindustrial combustion plants	323	179	97	1,737	0
Combustion in manufacturing industry	315	247	9	742	1
Production processes	68	14	139	649	9
Extraction and distribution of fossil fuels/geothermal energy	17	0	46	0	0
Solvent and other product use	0	0	1,113	0	1
Road transport	34	999	600	3,954	35
Other mobile sources and machinery	13	265	57	193	0
Waste treatment and disposal	0	0	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	0	0	666
Nature	0	0	425	0	0
Total	1,702	2,080	2,495	7,404	715
Comparable Total	1,702	2,080	2,069	7,404	715

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-5. 1996 Emission Estimates for Greece and Ireland by CORINAIR/EMEP Source Category and Pollutant

(thousand short tons)

Greece	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	435	91	4	8	0
Nonindustrial combustion plants	16	9	11	156	0
Combustion in manufacturing industry	88	26	8	17	0
Production processes	18	37	20	23	1
Extraction and distribution of fossil fuels/geothermal energy	0	0	18	0	0
Solvent and other product use	0	0	64	0	0
Road transport	10	114	208	1,038	1
Other mobile sources and machinery	28	110	19	144	0
Waste treatment and disposal	0	2	9	13	0
Agriculture and forestry, land use and woodstock change	0	5	53	127	85
Nature	0	0	0	0	0
Total	596	394	414	1,527	87
Comparable Total	596	394	362	1,527	87

Ireland	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	102	46	0	4	0
Nonindustrial combustion plants	31	9	6	62	0
Combustion in manufacturing industry	36	11	0	2	0
Production processes	0	0	1	0	0
Extraction and distribution of fossil fuels/geothermal energy	0	0	4	0	0
Solvent and other product use	0	0	24	0	0
Road transport	6	51	65	262	0
Other mobile sources and machinery	2	10	2	6	0
Waste treatment and disposal	0	0	0	1	0
Agriculture and forestry, land use and woodstock change	0	0	93	0	136
Nature	0	0	0	0	0
Total	178	127	196	337	137
Comparable Total	178	127	103	337	137

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-6. 1996 Emission Estimates for Luxembourg and the Netherlands by CORINAIR/EMEP Source Category and Pollutant

(thousand short tons)

Luxembourg	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	0	0	0	0	0
Nonindustrial combustion plants	1	1	1	9	0
Combustion in manufacturing industry	7	8	0	44	0
Production processes	0	0	1	9	2
Extraction and distribution of fossil fuels/geothermal energy	0	0	2	0	0
Solvent and other product use	0	0	4	0	0
Road transport	1	11	9	45	0
Other mobile sources and machinery	0	1	1	3	0
Waste treatment and disposal	0	0	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	1	0	6
Nature	0	0	1	0	0
Total	9	22	20	111	8
Comparable Total	9	22	18	111	8

Netherlands	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	53	71	2	20	0
Nonindustrial combustion plants	3	52	13	115	0
Combustion in manufacturing industry	34	61	8	72	0
Production processes	26	18	78	184	4
Extraction and distribution of fossil fuels/geothermal energy	0	0	31	0	0
Solvent and other product use	0	0	94	0	1
Road transport	12	233	148	536	0
Other mobile sources and machinery	19	100	13	41	0
Waste treatment and disposal	1	2	7	9	0
Agriculture and forestry, land use and woodstock change	0	17	3	19	155
Nature	0	1	0	9	7
Total	149	554	399	1,005	167
Comparable Total	149	553	395	996	161

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-7. 1996 Emission Estimates for Norway and Slovenia by CORINAIR/EMEP Source Category and Pollutant

(thousand short tons)

Norway	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	1	32	2	7	0
Nonindustrial combustion plants	2	3	11	153	0
Combustion in manufacturing industry	6	9	1	8	0
Production processes	23	10	20	44	0
Extraction and distribution of fossil fuels/geothermal energy	0	0	232	0	0
Solvent and other product use	0	0	52	0	0
Road transport	2	72	68	488	1
Other mobile sources and machinery	3	109	19	65	0
Waste treatment and disposal	0	7	1	1	0
Agriculture and forestry, land use and woodstock change	0	0	0	0	28
Nature	0	0	0	0	0
Total	37	243	406	766	29
Comparable Total	37	243	406	766	29

Slovenia	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	105	18	0	1	0
Nonindustrial combustion plants	8	3	0	4	0
Combustion in manufacturing industry	6	3	0	0	0
Production processes	0	0	0	0	0
Extraction and distribution of fossil fuels/geothermal energy	0	0	0	0	0
Solvent and other product use	0	0	0	0	0
Road transport	1	51	0	97	0
Other mobile sources and machinery	0	3	0	2	0
Waste treatment and disposal	0	0	0	0	0
Agriculture and forestry, land use and woodstock change	0	0	0	0	0
Nature	0	0	0	0	0
Total	121	77	0	105	0
Comparable Total	121	77	NA	105	NA

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-8. 1996 Emission Estimates for the United Kingdom by CORINAIR/EMEP Source Category and Pollutant

(thousand short tons)

United Kingdom	SO_2	NO_x	NMVOC	CO	NH_3
Combustion in energy and transformation industries	1,598	613	9	228	5
Nonindustrial combustion plants	141	126	37	258	0
Combustion in manufacturing industry	287	186	8	37	0
Production processes	109	5	201	50	0
Extraction and distribution of fossil fuels/geothermal energy	8	1	323	4	0
Solvent and other product use	0	0	666	0	0
Road transport	41	1,065	699	3,637	11
Other mobile sources and machinery	50	267	132	879	0
Waste treatment and disposal	1	8	51	27	12
Agriculture and forestry, land use and woodstock change	0	0	88	0	329
Nature	0	0	0	0	0
Total	2,235	2,271	2,215	5,121	357
Comparable Total	2,235	2,271	2,127	5,121	357

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-9. 1996 Emission Estimates for Austria, Belgium, Czech Republic, and Denmark by EEA Source Category and Pollutant

(thousand short tons; except CO_2 [million short tons])

Austria	CH_4	CO_2	N_2O
Energy	0	13	0
Industry	0	21	1
Transport	2	17	2
Agriculture	227	0	4
Waste	241	0	0
Other	22	4	2
Total	492	54	8

Belgium	CH_4	CO_2	N_2O
Energy	0	34	2
Industry	3	45	18
Transport	4	25	1
Agriculture	389	0	12
Waste	212	0	0
Other	51	37	7
Total	658	141	41

Czech Republic	CH_4	CO_2	N_2O
Energy	NA	NA	NA
Industry	NA	NA	NA
Transport	NA	NA	NA
Agriculture	NA	NA	NA
Waste	NA	NA	NA
Other	NA	NA	NA
Total	NA	NA	NA

Denmark	CH_4	CO_2	N_2O
Energy	2	49	2
Industry	1	8	0
Transport	3	13	1
Agriculture	354	0	33
Waste	81	0	0
Other	28	10	1
Total	469	80	37

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding. Negative emissions represent a sink for greenhouse gas.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-10. 1996 Emission Estimates for Estonia, Finland, France, and Germany by EEA Source Category and Pollutant

(thousand short tons; except CO_2 [million short tons])

Estonia	CH_4	CO_2	N_2O
Energy	0	22	0
Industry	0	0	0
Transport	0	2	0
Agriculture	33	0	0
Waste	34	0	0
Other	2	-3	1
Total	70	20	1

Finland	CH_4	CO_2	N_2O
Energy	2	30	3
Industry	7	16	5
Transport	3	12	2
Agriculture	90	0	10
Waste	176	0	0
Other	18	15	1
Total	298	73	20

France	CH_4	CO_2	N_2O
Energy	2	66	2
Industry	9	109	91
Transport	21	149	9
Agriculture	1,725	0	193
Waste	675	4	4
Other	565	48	27
Total	2,997	376	326

Germany	CH_4	CO_2	N_2O
Energy	8	398	14
Industry	9	182	99
Transport	32	192	23
Agriculture	1,712	2	94
Waste	873	0	4
Other	1,305	204	12
Total	3,939	976	247

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding. Negative emissions represent a sink for greenhouse gas.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-11. 1996 Emission Estimates for Greece, Ireland, Luxembourg, and Netherlands by EEA Source Category and Pollutant

(thousand short tons; except CO_2 [million short tons])

Greece	CH_4	CO_2	N_2O
Energy	0	50	3
Industry	3	21	3
Transport	7	19	1
Agriculture	309	0	22
Waste	125	0	0
Other	64	11	2
Total	505	101	33

Ireland	CH_4	CO_2	N_2O
Energy	0	15	2
Industry	0	6	3
Transport	2	7	1
Agriculture	722	0	21
Waste	112	0	0
Other	45	3	2
Total	881	31	29

Luxembourg	CH_4	CO_2	N_2O
Energy	0	1	0
Industry	0	4	0
Transport	0	1	0
Agriculture	19	0	1
Waste	4	0	0
Other	3	1	0
Total	26	7	1

Netherlands	CH_4	CO_2	N_2O
Energy	6	63	0
Industry	8	50	35
Transport	7	37	8
Agriculture	512	0	30
Waste	526	2	1
Other	242	51	5
Total	1302	204	79

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding. Negative emissions represent a sink for greenhouse gas.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-12. 1996 Emission Estimates for Norway, the Slovenia, Spain, and Sweden by EEA Source Category and Pollutant

(thousand short tons; except CO_2 [million short tons])

Norway	CH_4	CO_2	N_2O
Energy	3	11	0
Industry	1	13	6
Transport	3	16	1
Agriculture	119	0	10
Waste	214	0	0
Other	39	-14	0
Total	380	26	18

Slovenia	CH_4	CO_2	N_2O
Energy	NA	NA	NA
Industry	NA	NA	NA
Transport	NA	NA	NA
Agriculture	NA	NA	NA
Waste	NA	NA	NA
Other	NA	NA	NA
Total	NA	NA	NA

Spain	CH_4	CO_2	N_2O
Energy	13	78	11
Industry	7	70	15
Transport	12	72	4
Agriculture	1,128	0	66
Waste	903	0	0
Other	783	0	3
Total	2,846	220	99

Sweden	CH_4	CO_2	N_2O
Energy	2	16	2
Industry	6	20	7
Transport	21	22	2
Agriculture	180	0	18
Waste	67	0	0
Other	12	-22	1
Total	288	35	29

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding. Negative emissions represent a sink for greenhouse gas.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-13. 1996 Emission Estimates for the United Kingdom by EEA Source Category and Pollutant

(thousand short tons; except CO_2 [million short tons])

United Kingdom	CH_4	CO_2	N_2O
Energy	19	220	7
Industry	14	116	78
Transport	25	135	11
Agriculture	1,120	0	106
Waste	999	0	1
Other	924	170	2
Total	3,101	642	206

Note(s): NA = not available. Totals presented in this table may not equal the sum of the individual source categories due to rounding. Negative emissions represent a sink for greenhouse gas.

Source: ETC/Air Emissions (Database version 2.2, 10/25/99)[2]

Table 9-14. 1995 Emissions for Canada by Major Source Category

(thousand short tons)

Source Category	CO	NO_x	VOC	SO_2	TP	PM_{10}	$PM_{2.5}$
Industrial Sources	2,400	684	1,037	2,149	685	317	189
Nonindustrial Fuel Combustion	1,189	367	449	624	248	197	173
Transportation	7,394	1,422	810	150	108	105	92
Incineration	51	3	7	1	3	2	1
Miscellaneous	16	1	606	0	24	16	10
Open Sources	7,380	239	1,033	1	16,222	5,920	1,209
Total	**18,880**	**2,716**	**3,941**	**2,925**	**17,289**	**5,920**	**1,675**

Note(s): Totals presented in this table may not equal the sum of the individual source categories due to rounding.

Source: Environment Canada[3]

Table 9-15. 1995 Emissions for Canada by Province

(thousand short tons)

Source Category	CO	NO_x	VOC	SO2	TP	PM_{10}	$PM_{2.5}$
Alberta	2,206	720	841	670	5,573	1,742	296
British Columbia	1,904	291	290	194	713	334	193
Manitoba	1,718	120	262	403	1,085	449	147
New Brunswick	357	69	72	127	501	137	39
Newfoundland	262	47	58	72	368	113	34
Northwest Territories	2680	95	382	17	359	283	228
Nova Scotia	349	81	87	184	459	127	38
Ontario	4,186	613	906	697	3,867	1,151	287
Prince Edward Island	59	9	11	3	100	27	5
Quebec	2,728	422	537	412	2,375	713	195
Saskatchewan	2,173	236	459	145	1,812	209	190
Yukon	259	13	36	0	77	36	22
Total	**18,880**	**2,716**	**3,941**	**2,925**	**17,289**	**5,920**	**1,675**

Source: Environment Canada[3]

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Appendix A National Emissions (1970 to 1998) by Tier 3 Source Category and Pollutant

Table A-1. Carbon Monoxide Emissions
(thousand short tons)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	***237***	***276***	***322***	***291***	***314***	***321***	***363***	***349***	***350***	***363***	***370***	***372***	***391***	***405***	***417***
Coal	106	134	188	207	230	233	234	234	236	246	247	250	248	254	254
Oil	41	69	48	18	25	26	20	19	15	16	15	10	11	12	17
Gas	90	73	85	56	48	51	51	51	51	49	53	55	79	83	89
Internal Combustion	NA	NA	NA	10	11	11	57	45	47	51	55	58	54	56	57
FUEL COMB. INDUSTRIAL	***770***	***763***	***750***	***670***	***669***	***672***	***879***	***920***	***955***	***1,043***	***1,041***	***1,056***	***1,154***	***1,126***	***1,114***
Coal	100	67	58	86	87	87	105	101	102	101	100	98	108	106	104
Oil	44	49	35	47	46	46	74	60	64	66	66	71	60	58	56
Gas	462	463	418	257	265	271	226	284	300	322	337	345	335	334	330
Other	164	184	239	167	173	173	279	267	264	286	287	297	349	333	335
Internal Combustion	NA	NA	NA	113	98	96	195	208	227	268	251	245	301	295	289
FUEL COMB. OTHER	***3,625***	***3,441***	***6,230***	***7,525***	***6,390***	***6,450***	***4,269***	***4,587***	***4,849***	***4,181***	***4,108***	***4,506***	***4,603***	***3,892***	***3,843***
Commercial/Institutional Coal	12	17	13	14	15	15	14	14	15	15	15	15	12	12	13
Commercial/Institutional Oil	27	23	21	18	18	17	18	17	18	18	18	19	19	19	15
Commercial/Institutional Gas	24	25	26	42	47	49	44	44	51	53	54	54	58	59	57
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	57	55	55	149	141	141	143	147	145	54	57	58
Residential Wood	2,932	3,114	5,992	7,232	6,086	6,161	3,781	4,090	4,332	3,679	3,607	3,999	4,200	3,487	3,452
fireplaces	*2,932*	*3,114*	*5,992*	*7,232*	*6,086*	*6,161*	*3,781*	*4,090*	*4,332*	*3,679*	*3,607*	*3,999*	*3,598*	*2,906*	*2,906*
woodstoves	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*301*	*291*	*273*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*301*	*291*	*274*
Residential Other	630	262	178	162	168	153	262	281	292	274	268	273	260	257	247
CHEMICAL & ALLIED PRODUCT MFG	***3,397***	***2,204***	***2,151***	***1,845***	***1,917***	***1,925***	***1,183***	***1,127***	***1,112***	***1,093***	***1,171***	***1,223***	***1,100***	***1,119***	***1,129***
Organic Chemical Mfg	340	483	543	251	278	285	149	128	131	132	130	127	91	92	93
ethylene dichloride	*11*	*12*	*17*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
maleic anhydride	*73*	*147*	*103*	*16*	*16*	*16*	*3*	*3*	*4*	*4*	*4*	*4*	*0*	*0*	*0*
cyclohexanol	*36*	*39*	*37*	*5*	*6*	*6*	*0*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*0*
other	*220*	*286*	*386*	*230*	*256*	*264*	*146*	*125*	*127*	*128*	*125*	*123*	*91*	*92*	*93*
Inorganic Chemical Mfg	190	153	191	89	95	95	133	129	130	131	135	134	122	123	126
pigments; TiO2 chloride process: reactor	*18*	*22*	*34*	*77*	*83*	*84*	*119*	*119*	*119*	*119*	*119*	*119*	*119*	*120*	*122*
other	*172*	*131*	*157*	*12*	*12*	*12*	*14*	*11*	*12*	*13*	*16*	*15*	*3*	*3*	*3*
Polymer & Resin Mfg	NA	NA	NA	19	18	18	3	6	5	5	5	5	5	5	5
Agricultural Chemical Mfg	NA	NA	NA	16	17	17	44	19	19	18	17	17	12	12	12
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Pharmaceutical Mfg	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	2,866	1,567	1,417	1,471	1,509	1,510	854	844	827	805	885	939	870	886	893
carbon black mfg	*2,866*	*1,567*	*1,417*	*1,078*	*1,098*	*1,112*	*798*	*756*	*736*	*715*	*793*	*845*	*841*	*857*	*863*
carbon black furnace: fugitives	*NA*	*NA*	*NA*	*155*	*185*	*180*	*17*	*54*	*57*	*60*	*63*	*65*	*4*	*4*	*4*
other	*NA*	*NA*	*NA*	*238*	*226*	*219*	*39*	*35*	*34*	*30*	*30*	*29*	*26*	*26*	*26*

Table A-1 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
METALS PROCESSING	3,644	2,496	2,246	2,223	2,101	2,132	2,640	2,571	2,496	2,536	2,475	2,380	1,429	1,510	1,495
Nonferrous Metals Processing	652	636	842	694	656	677	436	438	432	423	421	424	442	456	446
aluminum anode baking	326	318	421	41	40	41	41	47	41	41	41	41	22	23	23
prebake aluminum cell	326	318	421	257	248	254	260	260	260	260	260	260	261	271	265
other	NA	NA	NA	396	368	382	135	131	131	122	120	123	158	162	158
Ferrous Metals Processing	2,991	1,859	1,404	1,523	1,439	1,449	2,163	2,108	2,038	2,089	2,029	1,930	944	1,009	1,006
basic oxygen furnace	440	125	80	694	650	662	594	731	767	768	677	561	117	126	126
carbon steel electric arc furnace	181	204	280	19	18	18	45	54	49	58	61	65	48	52	52
coke oven charging	62	53	43	9	9	9	14	16	17	7	7	8	5	5	5
gray iron cupola	1,203	649	340	302	288	280	124	118	114	121	128	120	121	125	120
iron ore sinter plant windbox	1,025	759	600	304	287	293	211	211	211	211	211	211	48	52	52
other	81	70	61	194	188	187	1,174	979	880	924	945	966	606	650	650
Metals Processing NEC	NA	NA	NA	6	6	6	40	25	26	25	25	25	42	45	43
PETROLEUM & RELATED INDUSTRIES	2,179	2,211	1,723	462	441	436	333	345	371	371	338	348	356	369	368
Oil & Gas Production	NA	NA	NA	11	8	8	38	18	21	22	35	34	26	27	27
Petroleum Refineries & Related Industries	2,168	2,211	1,723	449	431	427	291	324	345	344	299	309	322	335	334
fcc units	1,820	2,032	1,680	403	393	390	284	315	333	328	286	299	311	323	322
other	348	179	44	46	38	37	7	9	13	17	13	10	11	12	12
Asphalt Manufacturing	11	NA	NA	2	2	2	3	4	5	5	5	5	8	8	8
OTHER INDUSTRIAL PROCESSES	620	630	830	694	711	716	537	548	544	594	600	624	600	623	632
Agriculture, Food, & Kindred Products	NA	NA	NA	0	0	0	3	3	3	3	2	6	4	4	4
Textiles, Leather, & Apparel Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	610	602	798	627	649	655	473	461	449	453	461	484	391	407	416
sulfate pulping: rec. furnace/evaporator	NA	NA	NA	475	491	497	370	360	348	350	355	370	305	318	325
sulfate (kraft) pulping: lime kiln	610	602	798	140	145	146	87	81	75	78	76	82	55	57	59
other	NA	NA	NA	12	13	13	16	21	25	24	30	32	31	32	32
Rubber & Miscellaneous Plastic Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Mineral Products	10	27	32	43	44	43	54	77	85	131	131	127	184	189	189
Machinery Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	1	1	1
Electronic Equipment	NA	NA	NA	18	13	12	2	2	2	2	2	2	2	2	2
Transportation Equipment	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	6	5	5	5	5	6	4	4	4	19	19	19
SOLVENT UTILIZATION	NA	NA	NA	2	2	2	5	5	5	5	5	6	2	2	2
Degreasing	NA	NA	NA	1	1	1	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	NA	NA	NA	NA	NA	NA	0	0	0	0	1	1	1	1	1
Surface Coating	NA	NA	NA	0	1	1	0	1	1	1	1	1	1	1	1
Other Industrial	NA	NA	NA	0	0	0	4	4	4	4	4	4	0	0	0
Nonindustrial	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Solvent Utilization NEC				NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0

Table A-1 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
STORAGE & TRANSPORT	NA	NA	NA	49	56	55	76	28	17	51	24	25	78	80	80
Bulk Terminals & Plants	NA	NA	NA	0	0	0	0	2	0	4	4	4	4	4	4
Petroleum & Petroleum Product Storage	NA	NA	NA	0	0	0	0	12	0	32	4	4	4	4	4
Petroleum & Petroleum Product Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Service Stations: Stage I	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
Service Stations: Stage II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0
Organic Chemical Storage	NA	NA	NA	42	51	49	74	13	13	13	13	13	68	69	70
Organic Chemical Transport	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Inorganic Chemical Storage	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	6	5	5	1	1	3	2	3	3	2	2	2
WASTE DISPOSAL & RECYCLING	7,059	3,230	2,300	1,941	1,806	1,747	1,079	1,116	1,138	1,248	1,225	1,185	1,127	1,141	1,154
Incineration	2,979	1,764	1,246	958	903	876	372	392	404	497	467	432	404	408	413
conical wood burner	1,431	579	228	17	19	19	6	7	6	6	6	6	4	4	4
municipal incinerator	333	23	13	34	35	35	16	17	15	14	14	15	7	7	8
industrial	NA	NA	NA	9	10	9	9	10	10	87	48	10	9	9	9
commmercial/institutional	108	68	60	32	38	39	19	20	21	21	21	21	23	24	24
residential	1,107	1,094	945	865	800	773	294	312	324	340	347	351	330	333	336
other	NA	NA	NA	2	2	2	27	26	28	29	30	29	31	31	31
Open Burning	4,080	1,466	1,054	982	903	870	706	722	731	749	755	750	717	727	735
industrial	1,932	1,254	1,007	20	21	21	14	14	15	15	15	15	15	16	16
commmercial/institutional	2,148	212	47	4	4	5	46	48	50	52	54	52	87	90	93
residential	NA	NA	NA	958	877	845	509	516	523	529	533	536	515	519	524
other	NA	NA	NA	NA	NA	NA	137	144	144	153	153	147	101	101	102
POTW	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Industrial Waste Water	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
TSDF	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Landfills	NA	NA	NA	0	0	0	1	1	2	2	2	2	5	5	5
Other	NA	NA	NA	0	0	0	0	0	0	1	1	1	1	1	1
ON-ROAD VEHICLES	88,034	83,134	78,049	77,387	71,081	66,050	57,848	62,074	59,859	60,202	61,833	54,106	53,262	51,666	50,386
Light-Duty Gas Vehicles & Motorcycles	64,031	59,281	53,561	49,451	45,553	42,234	37,407	40,267	39,370	39,163	37,507	33,701	28,732	27,743	27,039
light-duty gas vehicles	63,846	59,061	53,342	49,273	45,367	42,047	37,198	40,089	39,190	38,973	37,312	33,500	28,543	27,555	26,848
motorcycles	185	220	219	178	186	187	209	177	180	190	195	200	189	188	190
Light-Duty Gas Trucks	16,570	15,767	16,137	18,960	17,133	15,940	13,816	15,014	14,567	15,196	17,350	14,829	19,271	18,943	18,726
light-duty gas trucks 1	10,102	9,611	10,395	11,834	9,890	9,034	8,415	8,450	8,161	8,430	9,534	8,415	11,060	10,917	10,826
light-duty gas trucks 2	6,468	6,156	5,742	7,126	7,244	6,906	5,402	6,565	6,407	6,766	7,815	6,414	8,211	8,027	7,900
Heavy-Duty Gas Vehicles	6,712	7,140	7,189	7,716	7,072	6,506	5,360	5,459	4,569	4,476	5,525	4,123	3,766	3,443	3,067
Diesels	721	945	1,161	1,261	1,322	1,369	1,265	1,334	1,352	1,367	1,451	1,453	1,493	1,537	1,554
heavy-duty diesel vehicles	721	915	1,139	1,235	1,290	1,336	1,229	1,298	1,315	1,328	1,411	1,412	1,453	1,497	1,514
light-duty diesel trucks	NA	NA	4	4	5	6	5	6	6	7	8	8	11	11	11
light-duty diesel vehicles	NA	30	19	22	26	28	31	30	31	33	32	33	29	29	30

Table A-1 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
NON-ROAD ENGINES AND VEHICLES	***11,970***	***13,109***	***14,489***	***15,999***	***17,346***	***17,779***	***18,191***	***18,585***	***18,999***	***19,391***	***19,796***	***20,224***	***20,232***	***20,314***	***19,914***
Non-Road Gasoline	10,946	11,754	12,760	13,659	14,680	15,021	15,394	15,738	16,081	16,424	16,765	17,112	17,074	17,163	16,812
recreational	*268*	*283*	*299*	*312*	*318*	*321*	*355*	*361*	*366*	*371*	*374*	*382*	*386*	*387*	*388*
construction	*358*	*393*	*527*	*603*	*603*	*603*	*603*	*602*	*602*	*602*	*602*	*602*	*582*	*568*	*557*
industrial	*535*	*586*	*709*	*807*	*757*	*740*	*723*	*707*	*690*	*674*	*657*	*640*	*592*	*583*	*563*
lawn & garden	*5,899*	*6,324*	*6,764*	*7,166*	*7,808*	*8,023*	*8,237*	*8,451*	*8,665*	*8,880*	*9,094*	*9,308*	*9,305*	*9,319*	*9,024*
farm	*202*	*267*	*338*	*372*	*398*	*407*	*416*	*424*	*433*	*442*	*450*	*459*	*466*	*469*	*469*
light commercial	*1,905*	*1,997*	*2,095*	*2,263*	*2,631*	*2,754*	*2,877*	*3,000*	*3,123*	*3,246*	*3,369*	*3,491*	*3,514*	*3,593*	*3,566*
logging	*10*	*23*	*28*	*31*	*43*	*47*	*50*	*54*	*58*	*62*	*66*	*69*	*73*	*74*	*75*
airport service	*6*	*8*	*9*	*10*	*10*	*10*	*10*	*10*	*9*	*9*	*9*	*9*	*9*	*9*	*8*
railway maintenance	*NA*	*NA*	*NA*	*5*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*7*	*7*	*7*	*6*
recreational marine vessels	*1,763*	*1,873*	*1,990*	*2,090*	*2,106*	*2,112*	*2,117*	*2,122*	*2,128*	*2,133*	*2,138*	*2,144*	*2,142*	*2,154*	*2,156*
Non-Road Diesel	430	650	829	900	1,025	1,062	1,098	1,134	1,169	1,204	1,238	1,269	1,282	1,254	1,180
recreational	*1*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
construction	*254*	*362*	*479*	*534*	*611*	*637*	*662*	*688*	*714*	*739*	*763*	*785*	*794*	*776*	*728*
industrial	*88*	*69*	*83*	*105*	*119*	*121*	*124*	*127*	*130*	*134*	*138*	*142*	*144*	*143*	*133*
lawn & garden	*6*	*12*	*13*	*14*	*23*	*26*	*29*	*32*	*34*	*37*	*39*	*42*	*44*	*46*	*47*
farm	*16*	*138*	*174*	*142*	*160*	*163*	*166*	*168*	*170*	*172*	*174*	*175*	*176*	*171*	*163*
light commercial	*20*	*27*	*28*	*34*	*42*	*44*	*46*	*48*	*49*	*51*	*52*	*54*	*55*	*55*	*53*
logging	*43*	*38*	*49*	*61*	*59*	*58*	*58*	*58*	*57*	*57*	*56*	*55*	*52*	*46*	*39*
airport service	*1*	*1*	*1*	*2*	*3*	*3*	*4*	*4*	*5*	*5*	*5*	*6*	*6*	*6*	*6*
railway maintenance	*UA*	*UA*	*UA*	*1*	*2*	*2*	*2*	*2*	*2*	*2*	*3*	*3*	*3*	*3*	*3*
recreational marine vessels	*UA*	*UA*	*UA*	*3*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*5*	*5*	*5*	*5*
Aircraft	506	600	743	831	931	955	904	888	901	905	915	942	949	946	955
Marine Vessels	23	28	62	73	92	98	129	136	132	126	127	127	134	136	138
coal	*2*	*2*	*4*	*5*	*6*	*7*	*4*	*4*	*4*	*4*	*5*	*4*	*4*	*4*	*4*
diesel	*21*	*25*	*57*	*67*	*84*	*90*	*80*	*83*	*79*	*75*	*76*	*77*	*128*	*130*	*131*
residual oil	*0*	*0*	*1*	*1*	*2*	*2*	*11*	*11*	*12*	*12*	*12*	*10*	*0*	*0*	*0*
gasoline	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*31*	*36*	*35*	*33*	*33*	*34*	*NA*	*NA*	*NA*
Railroads	65	77	96	106	118	121	121	120	125	120	114	114	112	116	115
Non-Road Other	0	0	0	430	499	522	545	568	591	614	637	660	681	699	714
liquified petroleum gas	*NA*	*NA*	*NA*	*288*	*354*	*376*	*398*	*420*	*442*	*464*	*486*	*508*	*530*	*545*	*561*
compressed natural gas	*NA*	*NA*	*NA*	*142*	*145*	*146*	*147*	*148*	*149*	*150*	*151*	*152*	*151*	*154*	*153*

Table A-1 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
MISCELLANEOUS	***7,909***	***5,263***	***8,344***	***7,927***	***15,895***	***8,153***	***11,122***	***8,618***	***6,934***	***7,082***	***9,656***	***7,298***	***11,144***	***12,164***	***8,920***
Agriculture & Forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	1	1
Other Combustion	7,909	5,263	8,344	7,927	15,895	8,153	11,122	8,618	6,934	7,082	9,656	7,298	11,144	12,164	8,919
Health Services	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA	NA
Cooling Towers	NA	NA	NA	NA	NA	NA	NA	0	0	NA	0	0	0	0	0
Fugitive Dust	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
TOTAL ALL SOURCES	129,444	116,757	117,434	117,013	118,729	106,439	98,523	100,872	97,630	98,160	102,643	93,353	95,479	94,410	89,454

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the ore aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-2. Nitrogen Oxide Emissions
(thousand short tons)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	**4,900**	**5,694**	**7,024**	**6,127**	**6,545**	**6,593**	**6,663**	**6,519**	**6,504**	**6,651**	**6,565**	**6,384**	**6,057**	**6,191**	**6,103**
Coal	3,888	4,828	6,123	5,240	5,666	5,676	5,642	5,559	5,579	5,744	5,636	5,579	5,542	5,609	5,395
bituminous	2,112	2,590	3,439	4,378	4,542	4,595	4,532	4,435	4,456	4,403	4,207	3,830	3,748	3,798	3,622
subbituminous	1,041	1,276	1,694	668	867	837	857	874	868	1,087	1,167	1,475	1,565	1,586	1,550
anthracite & lignite	344	414	542	194	256	245	254	250	255	255	262	273	229	225	222
other	391	548	447	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Oil	1,012	866	901	193	273	285	221	212	170	180	163	96	103	129	208
residual	40	101	39	178	256	268	207	198	158	166	149	94	101	127	206
distillate	972	765	862	15	16	17	14	14	13	14	14	2	2	2	2
other	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	UA	UA	UA
Gas	NA	NA	NA	646	557	582	565	580	579	551	591	562	265	299	344
natural	NA	NA	NA	646	557	582	565	580	579	551	591	562	264	297	342
process	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	2	2
Internal Combustion	NA	NA	NA	48	50	49	235	168	175	176	175	148	147	154	156
FUEL COMB. INDUSTRIAL	**4,325**	**4,007**	**3,555**	**3,209**	**3,187**	**3,209**	**3,035**	**2,979**	**3,071**	**3,151**	**3,147**	**3,144**	**3,072**	**3,019**	**2,969**
Coal	771	520	444	608	617	615	585	570	574	589	602	597	567	561	548
bituminous	532	359	306	430	447	446	399	387	405	413	420	412	398	394	386
subbituminous	164	111	94	14	15	14	18	20	21	28	38	46	46	46	45
anthracite & lignite	75	51	44	33	29	30	26	26	26	26	27	26	19	19	18
other	NA	NA	NA	131	126	124	141	137	122	122	117	112	104	103	100
Oil	332	354	286	309	296	294	265	237	244	245	241	247	231	223	216
residual	228	186	179	191	175	176	180	146	154	153	149	156	134	124	120
distillate	104	112	63	89	91	88	71	73	73	75	76	73	86	88	85
other	NA	56	44	29	31	29	14	18	17	17	17	17	11	12	11
Gas	3,060	2,983	2,619	1,520	1,584	1,625	1,182	1,250	1,301	1,330	1,333	1,324	1,184	1,168	1,154
natural	3,053	2,837	2,469	1,282	1,360	1,405	967	1,025	1,068	1,095	1,103	1,102	978	956	943
process	8	5	5	227	214	209	211	222	230	233	228	220	203	209	208
other	NA	140	145	11	10	10	3	3	3	2	2	2	2	3	3
Other	162	149	205	118	121	120	131	129	126	124	124	123	124	119	119
wood/bark waste	102	108	138	89	93	92	89	82	82	83	83	84	89	85	86
liquid waste	NA	NA	NA	12	12	12	8	11	10	11	11	11	8	8	8
other	60	41	67	17	16	16	34	36	34	30	30	28	26	26	25
Internal Combustion	NA	NA	NA	655	569	556	874	793	825	863	846	854	967	948	932
FUEL COMB. OTHER	**836**	**785**	**741**	**712**	**740**	**736**	**1,196**	**1,281**	**1,353**	**1,308**	**1,303**	**1,298**	**1,224**	**1,193**	**1,117**
Commercial/Institutional Coal	23	33	25	37	39	38	40	36	38	40	40	38	33	34	36
Commercial/Institutional Oil	210	176	155	106	117	106	97	88	93	93	95	103	92	94	77
Commercial/Institutional Gas	120	125	131	145	157	159	200	210	225	232	237	231	238	243	234
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	11	11	11	34	32	28	31	31	30	26	27	28
Residential Wood	44	39	74	88	74	75	46	50	53	45	44	49	51	43	42
Residential Other	439	412	356	326	343	347	780	865	916	867	857	847	783	752	700
distillate oil	118	113	85	75	80	78	209	211	210	210	210	210	194	190	173
natural gas	242	246	238	248	259	267	449	469	489	513	516	519	481	448	410
other	79	54	33	3	3	3	121	185	218	144	131	118	108	114	117

Table A-2 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
CHEMICAL & ALLIED PRODUCT MFG	***271***	***221***	***213***	***262***	***274***	***273***	***168***	***165***	***163***	***155***	***160***	***158***	***146***	***149***	***152***
Organic Chemical Mfg	70	53	54	37	42	42	18	22	22	19	20	20	20	20	20
Inorganic Chemical Mfg	201	168	159	22	18	18	12	12	10	5	6	7	5	5	5
Polymer & Resin Mfg	NA	NA	NA	22	23	23	6	6	6	5	5	4	2	2	2
Agricultural Chemical Mfg	NA	NA	NA	143	151	152	80	77	76	74	76	74	69	70	72
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Pharmaceutical Mfg	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	NA	NA	NA	38	40	39	52	48	50	51	54	54	50	51	52
METALS PROCESSING	***77***	***73***	***65***	***87***	***82***	***83***	***97***	***76***	***81***	***83***	***91***	***98***	***83***	***88***	***88***
Nonferrous Metals Processing	NA	NA	NA	16	15	15	14	15	13	12	12	12	10	11	11
Ferrous Metals Processing	77	73	65	58	53	54	78	56	62	67	75	83	70	74	74
Metals Processing NEC	NA	NA	NA	13	13	14	6	5	6	4	4	4	3	3	3
PETROLEUM & RELATED INDUSTRIES	***240***	***63***	***72***	***124***	***100***	***97***	***153***	***121***	***148***	***123***	***117***	***110***	***134***	***138***	***138***
Oil & Gas Production	NA	NA	NA	69	48	47	104	65	68	70	63	58	85	88	88
Petroleum Refineries & Related Industries	240	63	72	55	51	49	47	52	76	49	49	48	42	44	43
Asphalt Manufacturing	NA	NA	NA	1	1	1	3	4	4	5	5	5	7	7	7
OTHER INDUSTRIAL PROCESSES	***187***	***182***	***205***	***327***	***315***	***311***	***378***	***352***	***361***	***370***	***389***	***399***	***386***	***404***	***408***
Agriculture, Food, & Kindred Products	NA	NA	NA	5	5	5	3	3	3	4	3	6	4	5	5
Textiles, Leather, & Apparel Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	1	1	1
Wood, Pulp & Paper, & Publishing Products	18	18	24	73	76	77	91	88	86	86	89	89	80	83	84
Rubber & Miscellaneous Plastic Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Mineral Products	169	164	181	239	225	220	270	249	259	267	281	287	286	300	303
cement mfg	*97*	*89*	*98*	*137*	*126*	*124*	*151*	*131*	*139*	*143*	*150*	*153*	*172*	*181*	*182*
glass mfg	*48*	*53*	*60*	*48*	*46*	*45*	*59*	*59*	*61*	*64*	*66*	*67*	*58*	*62*	*63*
other	*24*	*23*	*23*	*54*	*53*	*51*	*61*	*59*	*60*	*60*	*64*	*66*	*56*	*58*	*58*
Machinery Products	NA	NA	NA	2	2	2	3	2	2	3	6	7	2	3	3
Electronic Equipment	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Transportation Equipment	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	8	7	7	10	10	10	9	9	10	12	13	13
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***2***	***3***	***3***	***1***	***2***	***3***	***3***	***3***	***3***	***2***	***2***	***2***
Degreasing	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	0	0	0	0	1	1	1	1	1	1	1	1
Dry Cleaning	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	NA	2	2	2	1	2	2	2	2	2	2	2	2
Other Industrial	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Nonindustrial	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Solvent Utilization NEC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0

Table A-2 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
STORAGE & TRANSPORT	**NA**	**NA**	**NA**	**2**	**2**	**2**	**3**	**6**	**5**	**5**	**5**	**6**	**7**	**7**	**7**
Bulk Terminals & Plants	NA	NA	NA	NA	NA	NA	0	1	1	1	1	1	1	1	1
Petroleum & Petroleum Product Storage	NA	NA	NA	1	1	1	2	2	0	0	0	0	0	0	0
Petroleum & Petroleum Product Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Service Stations: Stage I	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
Service Stations: Stage II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0
Organic Chemical Storage	NA	NA	NA	1	1	1	0	2	3	3	3	4	4	4	4
Organic Chemical Transport	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Inorganic Chemical Storage	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	0	1	1	0	0	0	0	0	1	2	2	2
WASTE DISPOSAL & RECYCLING	**440**	**159**	**111**	**87**	**85**	**84**	**91**	**95**	**96**	**123**	**114**	**99**	**95**	**96**	**97**
Incineration	110	56	37	27	31	31	49	51	51	74	65	53	50	50	51
Open Burning	330	103	74	59	54	52	42	43	43	44	44	44	43	43	44
POTW	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Industrial Waste Water	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
TSDF	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Landfills	NA	NA	NA	0	0	0	0	0	1	1	1	1	1	1	1
Other	NA	NA	NA	0	0	0	0	1	1	4	3	1	1	1	1
ON-ROAD VEHICLES	**7,390**	**8,645**	**8,621**	**8,089**	**7,661**	**7,682**	**7,089**	**7,469**	**7,622**	**7,806**	**8,075**	**7,826**	**7,848**	**7,875**	**7,765**
Light-Duty Gas Vehicles & Motorcycles	4,158	4,725	4,421	3,806	3,500	3,494	3,220	3,464	3,614	3,680	3,573	3,444	2,979	2,930	2,849
light-duty gas vehicles	4,156	4,722	4,416	3,797	3,489	3,483	3,208	3,453	3,602	3,668	3,560	3,431	2,967	2,918	2,837
motorcycles	2	3	5	9	11	11	12	11	12	12	13	13	12	12	12
Light-Duty Gas Trucks	1,278	1,461	1,408	1,530	1,419	1,386	1,256	1,339	1,356	1,420	1,657	1,520	1,950	1,955	1,917
light-duty gas trucks 1	725	819	864	926	824	803	784	782	792	828	960	902	1,156	1,155	1,132
light-duty gas trucks 2	553	642	544	603	595	584	472	557	564	592	697	617	794	800	785
Heavy-Duty Gas Vehicles	278	319	300	330	336	343	326	326	308	315	351	332	329	332	323
Diesels	1,676	2,141	2,493	2,423	2,406	2,458	2,287	2,339	2,345	2,390	2,494	2,531	2,591	2,658	2,676
heavy-duty diesel vehicles	1,676	2,118	2,463	2,389	2,366	2,416	2,240	2,294	2,298	2,343	2,446	2,482	2,544	2,611	2,630
light-duty diesel trucks	NA	NA	5	6	7	7	7	8	8	8	10	10	13	12	12
light-duty diesel vehicles	NA	23	25	28	33	35	39	37	39	39	38	39	35	34	34
NON-ROAD ENGINES AND VEHICLES	**1,931**	**2,638**	**3,529**	**3,859**	**4,404**	**4,528**	**4,804**	**4,900**	**4,934**	**4,942**	**5,015**	**5,128**	**5,167**	**5,251**	**5,280**
Non-Road Gasoline	85	92	101	108	112	114	120	121	123	124	126	127	132	146	159
recreational	1	1	1	1	1	1	6	6	6	6	6	6	6	6	6
construction	2	3	4	4	4	4	4	4	4	4	4	4	4	5	5
industrial	10	10	13	14	13	13	12	12	12	11	11	11	10	11	11
lawn & garden	26	28	29	31	34	35	36	37	38	39	40	41	42	52	60
farm	3	3	5	5	5	5	6	6	6	6	6	6	6	7	7
light commercial	10	10	11	12	14	14	15	16	16	17	18	18	19	24	27
logging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
airport service	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
railway maintenance	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
recreational marine vessels	34	36	38	40	41	41	41	41	41	41	41	41	43	42	42

Table A-2 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
NON-ROAD ENGINES AND VEHICLES (continued)															
Non-Road Diesel	1,109	1,666	2,125	2,155	2,429	2,472	2,513	2,552	2,595	2,640	2,687	2,739	2,786	2,806	2,809
recreational	0	2	2	2	2	3	3	3	3	3	3	3	3	3	3
construction	436	639	843	943	1,063	1,083	1,102	1,120	1,138	1,156	1,174	1,198	1,218	1,228	1,230
industrial	217	160	193	244	272	270	268	265	265	268	270	274	277	281	280
lawn & garden	9	18	19	22	36	40	45	50	54	59	64	69	73	78	82
farm	350	728	926	755	856	877	898	917	936	953	970	987	1,001	1,002	999
light commercial	31	43	44	54	68	72	77	82	87	91	96	101	106	110	113
logging	65	74	94	118	109	101	94	88	82	79	77	75	73	70	66
airport service	2	2	2	3	6	6	7	7	8	8	9	9	9	9	9
railway maintenance	UA	UA	UA	2	3	3	3	4	4	4	4	4	4	4	4
recreational marine vessels	UA	UA	UA	13	15	16	17	17	18	19	19	20	21	21	22
Aircraft	72	85	106	119	134	138	158	155	156	156	161	165	167	166	168
Marine Vessels	171	207	467	557	701	747	943	995	961	917	929	936	985	998	1,008
coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
diesel	144	175	396	469	590	628	630	649	621	593	604	615	975	987	997
residual oil	26	31	71	87	111	118	114	115	116	114	115	105	0	0	0
gasoline	NA	NA	NA	NA	NA	NA	10	10	9	9	9	10	10	10	11
other	NA	NA	NA	NA	NA	NA	190	221	214	201	201	206	NA	NA	NA
Railroads	495	589	731	808	897	923	929	929	946	945	947	990	922	952	947
Non-Road Other	0	0	0	112	129	135	141	147	153	159	165	171	177	183	189
liquified petroleum gas	NA	NA	NA	75	92	98	103	109	115	120	126	132	138	143	149
compressed natural gas	NA	NA	NA	37	38	38	38	38	39	39	39	39	39	40	40
MISCELLANEOUS	**330**	**165**	**248**	**310**	**727**	**293**	**369**	**286**	**255**	**241**	**390**	**267**	**452**	**411**	**328**
Agriculture and Forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	3	4
agricultural livestock	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	3	4
Other Combustion	330	165	248	310	727	293	368	285	253	240	388	265	448	407	324
Health Services	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0
Cooling Towers	NA	NA	NA	NA	NA	NA	NA	NA	0	NA	0	0	0	0	0
Fugitive Dust	NA	NA	NA	NA	NA	NA	1	1	1	1	1	1	1	1	1
TOTAL ALL SOURCES	20,928	22,632	24,384	23,198	24,124	23,893	24,049	24,249	24,596	24,961	25,372	24,921	24,676	24,824	24,454

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-3. Volatile Organic Compound Emissions
(thousand short tons)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	***30***	***40***	***45***	*32*	*37*	*37*	***47***	***44***	***44***	***45***	***45***	***44***	***49***	***51***	***54***
Coal	18	22	31	24	27	27	27	27	27	29	29	29	28	29	29
Oil	7	14	9	5	7	7	6	5	4	4	4	3	3	3	5
Gas	5	4	5	2	2	2	2	2	2	2	2	2	8	8	9
Internal Combustion	NA	NA	NA	1	1	1	12	10	10	10	10	10	10	11	11
FUEL COMB. INDUSTRIAL	***150***	***150***	***157***	***134***	***136***	***134***	***182***	***196***	***187***	***186***	***196***	***206***	***166***	***162***	***161***
Coal	4	3	3	7	7	7	7	6	7	6	8	6	6	6	6
Oil	4	5	3	17	16	16	12	11	12	12	12	12	8	8	8
Gas	77	71	62	57	61	61	58	60	52	51	63	73	49	49	49
Other	65	71	89	35	36	36	51	51	49	51	50	50	40	38	38
Internal Combustion	NA	NA	NA	18	15	15	54	68	66	66	64	65	62	61	60
FUEL COMB. OTHER	***541***	***470***	***848***	*1,403*	***1,188***	*1,200*	***776***	***835***	***884***	***762***	***748***	***823***	***821***	***686***	***678***
Commercial/Institutional Coal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Commercial/Institutional Oil	4	3	3	4	4	4	3	3	3	3	3	3	3	3	3
Commercial/Institutional Gas	6	7	7	6	6	7	8	8	10	11	11	11	13	13	12
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	4	4	4	8	8	8	9	9	8	8	8	9
Residential Wood	460	420	809	1,372	1,155	1,169	718	776	822	698	684	759	759	624	620
fireplaces	*460*	*420*	*809*	*1,372*	*1,155*	*1,169*	*718*	*776*	*822*	*698*	*684*	*759*	*684*	*551*	*551*
woodstoves	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*38*	*37*	*34*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*38*	*36*	*34*
Residential Other	70	38	28	16	17	15	38	39	40	40	40	41	37	36	34
CHEMICAL & ALLIED PRODUCT MFG	***1,341***	***1,351***	***1,595***	***881***	***982***	***980***	***634***	***710***	***715***	***701***	***691***	***660***	***388***	***390***	***396***
Organic Chemical Mfg	629	751	884	349	387	387	192	216	211	215	217	210	133	135	137
ethylene oxide mfg	*8*	*9*	*10*	*2*	*2*	*2*	*0*	*1*	*1*	*1*	*1*	*1*	*0*	*0*	*0*
phenol mfg	*NA*	*NA*	*NA*	*0*	*0*	*0*	*4*	*4*	*4*	*4*	*4*	*2*	*2*	*2*	*2*
terephthalic acid mfg	*29*	*46*	*60*	*24*	*26*	*27*	*20*	*23*	*17*	*19*	*21*	*17*	*11*	*11*	*11*
ethylene mfg	*70*	*79*	*111*	*28*	*33*	*33*	*9*	*11*	*10*	*10*	*9*	*10*	*5*	*5*	*5*
charcoal mfg	*48*	*29*	*40*	*37*	*43*	*45*	*33*	*33*	*33*	*33*	*34*	*33*	*31*	*32*	*32*
socmi reactor	*81*	*96*	*118*	*43*	*49*	*49*	*26*	*30*	*30*	*32*	*33*	*33*	*26*	*26*	*27*
socmi distillation	*NA*	*NA*	*NA*	*7*	*7*	*7*	*8*	*9*	*8*	*8*	*8*	*8*	*4*	*4*	*4*
socmi air oxidation processes	*NA*	*NA*	*NA*	*0*	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*2*	*1*	*1*	*1*
socmi fugitives	*194*	*235*	*254*	*179*	*194*	*193*	*61*	*67*	*69*	*70*	*70*	*70*	*42*	*43*	*44*
other	*199*	*257*	*291*	*27*	*31*	*30*	*29*	*38*	*37*	*36*	*35*	*34*	*12*	*12*	*12*
Inorganic Chemical Mfg	65	78	93	3	3	3	2	3	3	2	2	3	3	3	3
Polymer & Resin Mfg	271	299	384	343	392	389	242	268	283	269	257	222	126	123	125
polypropylene mfg	*0*	*0*	*1*	*12*	*13*	*13*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
polyethylene mfg	*17*	*18*	*22*	*51*	*58*	*57*	*39*	*44*	*45*	*46*	*46*	*35*	*16*	*16*	*16*
polystyrene resins	*10*	*11*	*15*	*6*	*7*	*7*	*4*	*5*	*5*	*5*	*5*	*5*	*4*	*2*	*2*

Table A-3 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
CHEMICAL & ALLIED PRODUCT MFG (continued)															
Polymer & Resin Mfg (continued)															
synthetic fiber	112	149	199	217	250	250	144	161	173	157	143	142	79	80	82
styrene/butadiene rubber	77	68	70	45	50	50	15	15	16	17	18	16	11	7	7
other	55	54	77	12	14	13	37	41	42	42	43	22	15	15	15
Agricultural Chemical Mfg	NA	NA	NA	11	12	12	6	7	8	7	6	5	8	8	8
Paint, Varnish, Lacquer, Enamel Mfg	61	66	65	8	8	8	14	16	17	18	17	18	7	8	8
paint & varnish mfg	61	66	65	8	8	8	13	15	16	16	16	16	6	6	6
other	NA	NA	NA	0	0	0	1	1	1	1	1	2	2	2	2
Pharmaceutical Mfg	40	55	77	43	48	48	20	21	24	23	24	38	8	8	8
Other Chemical Mfg	275	102	92	125	132	132	158	179	169	166	168	164	103	105	106
carbon black mfg	275	102	92	26	26	26	9	17	16	16	21	24	27	28	28
printing ink mfg	NA	NA	NA	2	3	3	1	1	1	1	2	2	1	1	1
fugitives unclassified	NA	NA	NA	12	13	12	23	23	21	20	27	30	13	13	13
carbon black furnace: fugitives	NA	NA	NA	4	5	5	0	1	1	1	1	1	0	0	0
other	NA	NA	NA	81	86	87	125	136	129	127	117	107	63	64	64
METALS PROCESSING	**394**	**336**	**273**	**76**	**74**	**74**	**122**	**123**	**124**	**124**	**126**	**125**	**72**	**76**	**75**
Nonferrous Metals Processing	NA	NA	NA	18	19	19	18	19	17	18	20	21	18	18	18
Ferrous Metals Processing	394	336	273	57	54	54	98	99	100	98	97	96	44	47	46
coke oven door & topside leaks	216	187	152	12	12	12	19	22	27	27	26	26	4	4	5
coke oven by-product plants	NA	NA	NA	3	3	3	7	9	9	9	9	9	5	5	5
other	177	149	121	41	39	39	71	68	63	62	62	61	35	37	37
Metals Processing NEC	NA	NA	NA	1	1	1	7	6	8	8	8	8	10	10	10
PETROLEUM & RELATED INDUSTRIES	**1,194**	**1,342**	**1,440**	**703**	**645**	**639**	**612**	**640**	**632**	**649**	**647**	**642**	**488**	**499**	**496**
Oil & Gas Production	411	378	379	107	71	68	301	301	297	310	305	299	267	270	268
Petroleum Refineries & Related Industries	773	951	1,045	592	571	568	308	337	332	336	339	339	216	224	224
vaccuum distillation	24	31	32	15	13	13	7	7	7	7	7	6	2	3	3
cracking units	27	27	21	34	32	31	15	17	16	15	16	16	16	17	17
process unit turnarounds	NA	NA	NA	15	13	13	11	11	11	11	10	12	2	2	2
petroleum refinery fugitives	NA	NA	NA	76	66	65	99	105	103	109	109	111	93	96	96
other	721	893	992	454	447	446	177	196	195	194	198	194	102	106	106
Asphalt Manufacturing	11	13	16	3	3	3	3	3	3	3	3	4	5	5	5

Table A-3 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
OTHER INDUSTRIAL PROCESSES	***270***	***235***	***237***	***390***	***408***	***403***	***401***	***391***	***414***	***442***	***438***	***450***	***428***	***444***	***450***
Agriculture, Food, & Kindred Products	208	182	191	169	177	175	138	130	127	146	145	147	120	124	125
vegetable oil mfg	*59*	*61*	*81*	*46*	*50*	*49*	*16*	*18*	*19*	*19*	*16*	*16*	*15*	*15*	*15*
whiskey fermentation: aging	*105*	*77*	*64*	*24*	*24*	*23*	*24*	*16*	*12*	*24*	*24*	*25*	*15*	*16*	*16*
bakeries	*45*	*44*	*46*	*51*	*52*	*51*	*43*	*44*	*44*	*46*	*46*	*47*	*40*	*42*	*42*
other	*NA*	*NA*	*NA*	*49*	*52*	*52*	*55*	*52*	*51*	*58*	*58*	*60*	*50*	*51*	*52*
Textiles, Leather, & Apparel Products	NA	NA	NA	10	10	10	20	18	19	19	19	19	14	15	15
Wood, Pulp & Paper, & Publishing Products	NA	NA	NA	42	44	44	96	92	101	112	105	122	140	145	148
Rubber & Miscellaneous Plastic Products	60	51	44	41	46	46	58	59	64	62	61	60	49	51	52
rubber tire mfg	*60*	*51*	*44*	*10*	*11*	*11*	*5*	*5*	*5*	*5*	*6*	*6*	*6*	*7*	*6*
green tire spray	*NA*	*NA*	*NA*	*5*	*6*	*6*	*3*	*4*	*3*	*3*	*3*	*3*	*2*	*2*	*2*
other	*NA*	*NA*	*NA*	*26*	*29*	*29*	*50*	*50*	*55*	*53*	*52*	*51*	*41*	*42*	*43*
Mineral Products	2	2	2	15	14	14	18	17	27	28	30	31	30	31	31
Machinery Products	NA	NA	NA	4	4	4	7	8	10	8	11	11	11	12	12
Electronic Equipment	NA	NA	NA	0	0	0	2	2	3	3	3	2	2	2	2
Transportation Equipment	NA	NA	NA	1	0	0	2	2	2	3	3	2	4	4	4
Construction	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	108	112	109	59	62	62	62	62	57	59	60	61
SOLVENT UTILIZATION	***7,174***	***5,651***	***6,584***	***5,699***	***5,945***	***5,964***	***5,750***	***5,782***	***5,901***	***6,016***	***6,162***	***6,183***	***5,506***	***5,654***	***5,278***
Degreasing	707	448	513	756	754	757	744	718	737	753	775	789	606	628	457
open top	*NA*	*NA*	*NA*	*28*	*29*	*29*	*18*	*25*	*26*	*26*	*27*	*24*	*8*	*9*	*8*
conveyorized	*NA*	*NA*	*NA*	*5*	*5*	*4*	*5*	*6*	*6*	*6*	*6*	*5*	*4*	*4*	*4*
cold cleaning	*NA*	*NA*	*NA*	*31*	*34*	*35*	*30*	*23*	*24*	*24*	*22*	*23*	*23*	*24*	*24*
other	*707*	*448*	*513*	*691*	*687*	*689*	*691*	*664*	*680*	*697*	*719*	*737*	*571*	*591*	*421*
Graphic Arts	319	254	373	317	362	363	274	301	308	322	333	339	296	303	311
letterpress	*NA*	*NA*	*NA*	*2*	*2*	*2*	*4*	*8*	*8*	*8*	*8*	*8*	*6*	*6*	*6*
flexographic	*NA*	*NA*	*NA*	*18*	*20*	*20*	*20*	*24*	*26*	*26*	*25*	*24*	*20*	*20*	*20*
lithographic	*NA*	*NA*	*NA*	*4*	*4*	*4*	*14*	*17*	*18*	*21*	*22*	*20*	*13*	*13*	*13*
gravure	*NA*	*NA*	*NA*	*131*	*148*	*150*	*75*	*82*	*81*	*87*	*93*	*91*	*55*	*56*	*58*
other	*319*	*254*	*373*	*162*	*188*	*187*	*162*	*171*	*175*	*180*	*185*	*196*	*203*	*208*	*213*
Dry Cleaning	263	229	320	169	216	212	215	218	224	225	228	230	157	166	169
perchloroethylene	*NA*	*NA*	*NA*	*85*	*109*	*107*	*110*	*112*	*115*	*116*	*117*	*118*	*60*	*64*	*65*
petroleum solvent	*NA*	*NA*	*NA*	*84*	*106*	*105*	*104*	*106*	*109*	*110*	*111*	*112*	*92*	*97*	*99*
other	*263*	*229*	*320*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*5*	*5*	*5*

Table A-3 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
SOLVENT UTILIZATION (continued)															
Surface Coating	3,570	2,977	3,685	2,549	2,646	2,635	2,523	2,521	2,577	2,632	2,716	2,681	2,389	2,472	2,224
industrial adhesives	52	41	55	381	366	375	390	374	386	400	419	410	356	372	160
fabrics	161	177	186	34	35	35	14	14	16	16	15	15	11	11	11
paper	652	548	626	106	114	114	75	64	61	59	59	52	49	50	51
large appliances	49	43	36	22	19	18	21	20	20	21	22	21	23	24	23
magnet wire	7	6	5	0	0	0	1	1	1	1	1	1	2	2	2
autos & light trucks	165	204	165	85	87	87	92	90	93	92	96	96	97	103	106
metal cans	49	57	73	97	96	95	94	91	93	96	98	102	99	106	109
metal coil	18	19	21	50	50	50	45	49	47	49	48	47	46	48	49
wood furniture	211	231	231	132	143	140	158	154	159	171	185	179	177	187	136
metal furniture	35	42	52	41	44	44	48	47	49	52	56	53	52	55	57
flatwood products	64	76	82	4	4	4	9	10	10	11	12	13	14	15	15
plastic parts	17	18	25	11	11	11	27	22	23	22	22	18	16	16	17
large ships	21	20	20	15	16	15	15	14	15	15	15	13	16	17	18
aircraft	1	1	2	27	31	34	7	7	7	7	7	6	11	11	12
misc. metal parts	NA	NA	NA	14	14	14	59	87	90	92	93	92	38	39	40
steel drums	NA	NA	NA	NA	NA	NA	3	3	3	3	4	4	3	4	4
architectural	442	407	477	473	504	500	495	500	505	510	515	522	484	489	491
traffic markings	NA	NA	NA	100	107	106	105	106	107	108	109	111	94	95	95
maintenance coatings	108	125	106	79	80	80	79	76	78	81	85	84	80	83	84
railroad	5	7	9	4	3	3	3	3	3	3	4	4	3	3	4
auto refinishing	83	143	186	111	133	132	130	132	137	140	144	142	160	161	161
machinery	39	51	62	37	29	28	28	26	26	27	27	25	25	25	23
electronic & other electrical	NA	NA	NA	79	80	79	78	75	77	80	85	85	79	83	83
general	79	61	52	146	158	154	121	127	129	133	140	138	98	103	104
miscellaneous	942	392	799	104	105	103	32	37	42	39	38	35	31	33	33
thinning solvents	NA	NA	NA	90	97	96	96	97	100	94	96	99	50	52	53
other	372	309	415	306	320	317	297	295	302	310	321	314	276	283	285
Other Industrial	640	499	690	125	133	131	94	98	102	102	99	96	99	103	104
miscellaneous	39	30	44	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
rubber & plastics mfg	309	245	327	25	29	29	28	28	28	29	31	31	39	40	40
other	292	224	319	100	104	102	66	71	74	73	68	64	60	63	64

Table A-3 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
SOLVENT UTILIZATION (continued)															
Nonindustrial	1,674	1,243	1,002	1,783	1,834	1,867	1,900	1,925	1,952	1,982	2,011	2,048	1,957	1,980	2,012
cutback asphalt	1,045	723	323	191	199	199	199	202	207	214	221	227	135	140	144
other asphalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	42	44	45
pesticide application	241	195	241	212	262	260	258	264	272	280	289	299	386	391	405
adhesives	NA	NA	NA	345	345	353	361	365	368	372	375	380	307	310	313
consumer solvents	NA	NA	NA	1,035	1,030	1,056	1,083	1,095	1,105	1,116	1,126	1,142	1,081	1,090	1,099
other	387	325	437	NA	NA	NA	NA	NA	NA	NA	NA	NA	6	6	6
Other	NA	NA	NA	NA	NA	NA	0	NA	NA	0	0	0	3	3	3
STORAGE & TRANSPORT	***1,954***	***2,181***	***1,975***	***1,747***	***1,842***	***1,753***	***1,495***	***1,532***	***1,583***	***1,600***	***1,629***	***1,652***	***1,286***	***1,324***	***1,324***
Bulk Terminals & Plants	599	668	517	606	652	651	359	369	384	395	403	406	211	218	217
fixed roof	14	15	12	14	15	15	9	11	12	13	16	16	7	8	7
floating roof	45	50	39	46	50	50	26	29	30	34	29	19	12	12	12
variable vapor space	1	1	1	1	1	1	2	2	1	1	1	0	0	0	0
efr with seals	NA	NA	NA	NA	NA	NA	2	3	3	4	4	3	3	3	3
ifr with seals	NA	NA	NA	NA	NA	NA	2	2	3	5	3	3	3	3	3
underground tanks	NA	0	0	0	0	0	1	2	2	2	2	2	2	2	2
area source: gasoline	509	569	440	512	554	553	282	281	292	292	305	322	163	167	167
other	30	33	26	32	33	33	36	40	42	44	43	41	22	23	22
Petroleum & Petroleum Product Storage	300	315	306	223	215	210	157	195	204	205	194	191	172	178	178
fixed roof gasoline	47	52	43	26	24	23	13	17	17	16	16	16	10	11	11
fixed roof crude	135	141	148	26	21	21	21	25	26	28	24	21	26	27	26
floating roof gasoline	49	54	45	27	25	24	15	25	24	24	22	22	16	16	16
floating roof crude	32	34	36	5	5	5	2	7	7	8	6	6	5	5	5
efr / seal gasoline	3	4	3	2	2	2	7	11	13	14	14	15	9	9	9
efr / seal crude	1	2	2	0	0	0	3	3	3	3	3	2	3	3	3
ifr / seal gasoline	1	2	1	1	1	1	1	2	2	2	2	2	2	2	2
ifr / seal crude	2	2	2	0	0	0	0	0	0	0	0	0	1	1	1
variable vapor space gasoline	3	3	3	1	1	2	1	2	5	6	3	0	0	0	0
area source: crude	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
other	25	22	23	133	135	132	92	102	106	103	103	106	100	103	104
Petroleum & Petroleum Product Transport	92	84	61	126	125	125	151	146	149	142	139	134	118	122	122
gasoline loading: normal / splash	3	2	0	3	3	3	3	2	2	2	3	2	3	3	3
gasoline loading: balanced / submerged	20	13	2	21	21	22	15	17	15	13	11	10	8	9	9
gasoline loading: normal / submerged	39	26	3	41	41	42	26	25	26	24	25	23	13	13	13
gasoline loading: clean / submerged	2	1	0	2	2	2	0	0	0	0	0	0	0	0	0
marine vessel loading: gasoline & crude	26	38	50	24	23	22	31	30	30	29	28	29	30	31	31
other	2	4	6	35	35	35	76	73	75	73	72	70	64	65	65

Table A-3 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
STORAGE & TRANSPORT (continued)															
Service Stations: Stage I	416	481	461	207	223	223	300	295	303	309	322	334	312	320	320
Service Stations: Stage II	521	602	583	485	522	441	433	430	442	449	467	484	397	409	409
Service Stations: Breathing & Emptying	NA	NA	NA	49	52	52	52	51	52	53	55	57	43	44	44
Organic Chemical Storage	26	31	46	34	37	36	30	35	38	39	39	37	26	26	26
Organic Chemical Transport	NA	NA	NA	17	16	15	10	8	8	7	7	7	5	5	5
Inorganic Chemical Storage	NA	NA	NA	0	0	0	0	1	1	1	1	1	1	1	1
Inorganic Chemical Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	0	0	0	2	2	2	1	1	1	1	1	1
Bulk Materials Transport	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
WASTE DISPOSAL & RECYCLING	***1,984***	***984***	***758***	***979***	***959***	***941***	***986***	***999***	***1,010***	***1,046***	***1,046***	***1,067***	***423***	***427***	***433***
Incineration	548	453	366	64	60	59	48	50	51	76	65	54	51	52	52
Open Burning	1,424	517	372	309	284	274	196	200	203	207	208	208	200	203	205
industrial	*NA*	*NA*	*NA*	*6*	*6*	*6*	*4*	*4*	*4*	*5*	*5*	*5*	*5*	*5*	*5*
commmercial/institutional	*NA*	*NA*	*NA*	*1*	*2*	*2*	*9*	*9*	*10*	*10*	*10*	*10*	*19*	*20*	*20*
residential	*NA*	*NA*	*NA*	*302*	*277*	*266*	*165*	*167*	*169*	*171*	*172*	*173*	*167*	*168*	*170*
other	*1,424*	*517*	*372*	*NA*	*NA*	*NA*	*19*	*20*	*20*	*21*	*21*	*20*	*9*	*10*	*10*
POTW	NA	NA	NA	10	11	11	49	47	48	50	52	51	49	49	50
Industrial Waste Water	NA	NA	NA	1	2	2	14	18	19	19	19	16	19	19	20
TSDF	NA	NA	NA	594	602	595	589	591	589	588	587	628	42	42	43
Landfills	NA	NA	NA	0	0	0	64	66	69	74	80	75	32	32	33
Other	11	14	20	0	0	0	26	28	31	33	35	36	29	29	30
ON-ROAD VEHICLES	***12,972***	***10,545***	***8,979***	***9,376***	***8,290***	***7,192***	***6,313***	***6,499***	***6,072***	***6,103***	***6,401***	***5,701***	***5,490***	***5,330***	***5,325***
Light-Duty Gas Vehicles & Motorcycles	9,193	7,248	5,907	5,864	5,189	4,462	3,947	4,069	3,832	3,812	3,748	3,426	2,875	2,796	2,832
light-duty gas vehicles	*9,133*	*7,177*	*5,843*	*5,810*	*5,136*	*4,412*	*3,885*	*4,033*	*3,799*	*3,777*	*3,711*	*3,385*	*2,839*	*2,761*	*2,793*
motorcycles	*60*	*71*	*64*	*54*	*53*	*50*	*62*	*37*	*33*	*34*	*37*	*41*	*36*	*36*	*39*
Light-Duty Gas Trucks	2,770	2,289	2,059	2,425	2,129	1,867	1,622	1,688	1,588	1,647	1,909	1,629	2,060	2,017	2,015
light-duty gas trucks 1	*1,564*	*1,251*	*1,229*	*1,437*	*1,173*	*1,018*	*960*	*906*	*849*	*875*	*1,003*	*895*	*1,143*	*1,128*	*1,138*
light-duty gas trucks 2	*1,206*	*1,038*	*830*	*988*	*956*	*849*	*662*	*781*	*739*	*772*	*906*	*735*	*917*	*889*	*877*
Heavy-Duty Gas Vehicles	743	657	611	716	626	517	432	423	334	326	414	327	293	272	257
Diesels	266	351	402	370	345	346	312	319	318	318	331	319	263	244	222
heavy-duty diesel vehicles	*266*	*335*	*392*	*360*	*332*	*332*	*297*	*304*	*302*	*301*	*313*	*302*	*245*	*227*	*205*
light-duty diesel trucks	*NA*	*NA*	*2*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*4*	*4*	*5*	*5*	*5*
light-duty diesel vehicles	*NA*	*15*	*8*	*8*	*10*	*11*	*13*	*12*	*13*	*13*	*13*	*14*	*12*	*12*	*12*

Table A-3 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
NON-ROAD ENGINES AND VEHICLES	***1,878***	***2,078***	***2,312***	***2,442***	***2,572***	***2,552***	***2,545***	***2,581***	***2,594***	***2,624***	***2,672***	***2,699***	***2,664***	***2,572***	***2,461***
Non-Road Gasoline	1,564	1,669	1,787	1,886	1,942	1,907	1,889	1,920	1,925	1,957	1,991	2,021	1,982	1,895	1,794
recreational	138	145	151	156	159	160	128	130	132	133	135	138	135	135	135
construction	27	29	39	45	45	44	44	44	44	44	44	44	40	34	30
industrial	25	27	33	37	35	33	33	32	31	30	29	28	25	23	21
lawn & garden	511	547	583	616	669	682	700	718	734	752	771	789	771	712	638
farm	10	14	17	19	20	20	20	21	21	21	22	22	22	22	21
light commercial	115	121	127	137	159	164	171	179	185	192	200	207	199	177	155
logging	2	4	5	5	7	8	9	9	10	11	11	12	13	13	13
airport service	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0
railway maintenance	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
recreational marine vessels	736	782	830	869	847	793	784	787	768	772	778	779	777	781	780
Non-Road Diesel	187	257	327	332	377	384	390	397	403	408	414	420	422	416	405
recreational	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
construction	94	103	135	151	171	176	181	185	190	194	199	204	206	205	199
industrial	38	23	28	36	40	40	40	41	41	42	42	43	44	44	43
lawn & garden	3	4	4	5	8	9	10	11	12	13	14	14	15	16	17
farm	39	109	138	113	126	127	126	126	125	124	123	121	120	116	111
light commercial	7	8	8	10	12	13	13	14	14	15	16	16	17	17	17
logging	6	9	11	14	14	14	14	15	15	15	14	14	14	12	11
airport service	0	0	0	1	1	1	1	1	2	2	2	2	2	2	2
railway maintenance	UA	UA	UA	1	1	1	1	1	1	1	1	1	1	1	1
recreational marine vessels	UA	UA	UA	2	2	3	3	3	3	3	3	3	3	3	3
Aircraft	97	116	146	165	185	190	180	177	179	176	176	178	177	176	177
Marine Vessels	7	8	19	22	28	30	32	34	33	32	43	32	34	34	35
coal	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0
diesel	6	8	17	20	26	27	21	22	21	20	27	20	32	33	33
residual oil	0	1	1	1	2	2	3	3	3	3	4	3	0	0	0
gasoline	NA	NA	NA	NA	NA	NA	1	1	1	1	1	1	1	1	1
other	NA	NA	NA	NA	NA	NA	7	8	8	8	11	8	NA	NA	NA
Railroads	22	27	33	37	41	42	52	52	54	52	49	49	48	50	50
Non-Road Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
liquified petroleum gas	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
compressed natural gas	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0

Table A-3 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
NATURAL SOURCES	***NA***	***NA***	***NA***	***NA***	***NA***	***NA***	***14***	***14***	***14***	***14***	***14***	***14***	***14***	***14***	***14***
Geogenic	NA	NA	NA	NA	NA	NA	14	14	14	14	14	14	14	14	14
MISCELLANEOUS	***1,101***	***716***	***1,134***	***566***	***1,230***	***642***	***1,059***	***756***	***486***	***556***	***720***	***551***	***940***	***1,249***	***772***
Agriculture & Forestry	NA	NA	NA	NA	NA	NA	5	6	6	6	6	7	42	43	44
Other Combustion	1,101	716	1,134	565	1,230	641	1,049	743	474	544	707	537	891	1,199	721
Catastrophic/Accidental Releases	NA	NA	NA	NA	NA	NA	4	4	4	4	4	4	5	5	5
Health Services	NA	NA	NA	0	1	1	1	0	1	1	1	1	0	1	1
Cooling Towers	NA	NA	NA	NA	NA	NA	0	2	2	1	2	2	1	1	1
Fugitive Dust	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
TOTAL ALL SOURCES	30,982	26,079	26,336	24,428	24,306	22,513	20,936	21,102	20,659	20,868	21,535	20,817	18,736	18,876	17,917

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.
"Other" categories may contain emissions that could not be accurately allocated to specific source categories.
Zero values represent less than 500 short tons/year.
No data was available after 1984 to weigh the emissions from residential wood burning devices.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-4. Sulfur Dioxide Emissions (thousand short tons)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	***17,398***	***18,268***	***17,469***	***16,272***	***15,987***	***16,215***	***15,909***	***15,784***	***15,416***	***15,189***	***14,889***	***12,080***	***12,631***	***13,090***	***13,217***
Coal	15,799	16,756	16,073	15,630	15,221	15,404	15,220	15,087	14,824	14,527	14,313	11,603	12,137	12,542	12,426
bituminous	*9,574*	*10,161*	*NA*	*14,029*	*13,548*	*13,579*	*13,371*	*13,215*	*12,914*	*12,212*	*11,841*	*8,609*	*8,931*	*9,446*	*9,368*
subbituminous	*4,716*	*5,005*	*NA*	*1,292*	*1,310*	*1,422*	*1,415*	*1,381*	*1,455*	*1,796*	*1,988*	*2,345*	*2,630*	*2,488*	*2,440*
anthracite & lignite	*1,509*	*1,590*	*NA*	*309*	*364*	*404*	*434*	*491*	*455*	*519*	*484*	*649*	*576*	*608*	*618*
Oil	1,598	1,511	1,395	612	734	779	639	652	546	612	522	413	436	488	730
residual	*1,578*	*1,462*	*NA*	*604*	*722*	*765*	*629*	*642*	*537*	*601*	*512*	*408*	*430*	*484*	*726*
distillate	*20*	*49*	*NA*	*8*	*12*	*14*	*10*	*10*	*9*	*10*	*10*	*5*	*6*	*4*	*4*
Gas	1	1	1	1	1	1	1	1	1	1	1	9	3	1	2
Internal Combustion	NA	NA	NA	30	31	30	49	45	46	49	53	55	56	59	60
FUEL COMB. INDUSTRIAL	***4,568***	***3,310***	***2,951***	***3,169***	***3,111***	***3,086***	***3,550***	***3,256***	***3,292***	***3,284***	***3,218***	***3,357***	***3,022***	***2,964***	***2,895***
Coal	3,129	1,870	1,527	1,818	1,856	1,840	1,914	1,805	1,783	1,763	1,740	1,728	1,465	1,450	1,415
bituminous	*2,171*	*1,297*	*1,058*	*1,347*	*1,395*	*1,384*	*1,050*	*949*	*1,005*	*991*	*988*	*1,003*	*1,031*	*1,022*	*1,000*
subbituminous	*669*	*399*	*326*	*28*	*29*	*29*	*50*	*53*	*60*	*67*	*77*	*81*	*64*	*63*	*62*
anthracite & lignite	*289*	*174*	*144*	*90*	*79*	*79*	*67*	*68*	*67*	*68*	*68*	*68*	*59*	*59*	*55*
other	*NA*	*NA*	*NA*	*353*	*353*	*348*	*746*	*735*	*650*	*636*	*606*	*576*	*312*	*306*	*298*
Oil	1,229	1,139	1,065	862	806	812	927	779	801	809	777	912	844	801	773
residual	*956*	*825*	*851*	*671*	*614*	*625*	*687*	*550*	*591*	*597*	*564*	*701*	*637*	*588*	*568*
distillate	*98*	*144*	*85*	*111*	*108*	*107*	*198*	*190*	*191*	*193*	*193*	*191*	*187*	*190*	*184*
other	*175*	*171*	*129*	*80*	*84*	*80*	*42*	*39*	*20*	*20*	*20*	*20*	*20*	*22*	*21*
Gas	140	263	299	397	360	346	543	516	552	555	542	548	556	563	558
Other	70	38	60	86	83	82	158	142	140	140	141	147	140	134	133
Internal Combustion	NA	NA	NA	7	6	6	9	14	16	17	19	23	17	16	16
FUEL COMB. OTHER	***1,490***	***1,082***	***971***	***579***	***660***	***624***	***831***	***755***	***784***	***772***	***780***	***793***	***667***	***677***	***609***
Commercial/Institutional Coal	109	147	110	158	172	169	212	184	190	193	192	200	177	183	194
Commercial/Institutional Oil	883	638	637	239	295	274	425	376	396	381	391	397	338	345	275
Commercial/Institutional Gas	1	1	1	2	2	2	7	7	7	8	8	8	10	10	10
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	1	1	1	6	6	6	6	6	5	4	4	4
Residential Wood	6	7	13	13	11	11	7	7	8	6	6	7	7	6	6
Residential Other	492	290	211	167	180	167	175	176	177	178	177	176	131	130	121
distillate oil	*212*	*196*	*157*	*128*	*137*	*132*	*137*	*141*	*144*	*145*	*145*	*144*	*108*	*106*	*97*
bituminous/subbituminous coal	*260*	*76*	*43*	*29*	*33*	*27*	*30*	*26*	*26*	*25*	*25*	*24*	*17*	*18*	*18*
other	*20*	*18*	*11*	*10*	*10*	*8*	*9*	*8*	*8*	*8*	*8*	*8*	*6*	*6*	*6*

Table A-4 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
CHEMICAL & ALLIED PRODUCT MFG	***591***	***367***	***280***	***456***	***449***	***440***	***297***	***280***	***278***	***269***	***275***	***286***	***291***	***296***	***299***
Organic Chemical Mfg	NA	NA	NA	16	19	17	10	9	9	9	8	8	4	4	4
Inorganic Chemical Mfg	591	358	271	354	341	334	214	208	203	191	194	199	204	208	210
sulfur compounds	*591*	*358*	*271*	*346*	*333*	*326*	*211*	*205*	*199*	*187*	*189*	*195*	*202*	*206*	*208*
other	*NA*	*NA*	*NA*	*8*	*8*	*8*	*2*	*3*	*4*	*4*	*4*	*4*	*2*	*2*	*2*
Polymer & Resin Mfg	NA	NA	NA	7	7	7	1	1	1	1	1	0	1	1	1
Agricultural Chemical Mfg	NA	NA	NA	4	4	4	5	4	4	4	4	5	1	1	1
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0
Pharmaceutical Mfg	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	NA	8	10	76	78	77	67	57	60	64	68	74	81	82	82
METALS PROCESSING	***4,775***	***2,849***	***1,842***	***1,042***	***707***	***695***	***726***	***612***	***615***	***603***	***562***	***530***	***429***	***450***	***444***
Nonferrous Metals Processing	4,060	2,165	1,279	853	529	513	517	435	438	431	391	361	283	294	288
copper	*3,507*	*1,946*	*1,080*	*655*	*343*	*327*	*323*	*234*	*247*	*250*	*206*	*177*	*114*	*120*	*119*
lead	*77*	*34*	*34*	*121*	*113*	*113*	*129*	*135*	*131*	*122*	*128*	*126*	*111*	*113*	*110*
aluminum	*80*	*72*	*95*	*62*	*59*	*60*	*60*	*61*	*55*	*53*	*51*	*53*	*54*	*56*	*54*
other	*396*	*113*	*71*	*14*	*14*	*13*	*4*	*5*	*5*	*6*	*6*	*6*	*5*	*5*	*5*
Ferrous Metals Processing	715	684	562	172	162	165	186	159	158	153	153	151	128	138	139
Metals Processing NEC	NA	NA	NA	18	16	17	22	18	18	19	19	18	17	18	17
PETROLEUM & RELATED INDUSTRIES	***881***	***727***	***734***	***505***	***443***	***429***	***430***	***378***	***416***	***383***	***379***	***369***	***337***	***346***	***345***
Oil & Gas Production	111	173	157	204	159	156	122	98	93	98	95	89	95	96	96
natural gas	*111*	*173*	*157*	*202*	*157*	*155*	*120*	*96*	*92*	*96*	*93*	*88*	*95*	*96*	*95*
other	*NA*	*NA*	*NA*	*2*	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*1*	*1*	*1*	*1*
Petroleum Refineries & Related Industries	770	554	577	300	283	272	304	274	315	278	276	271	234	242	241
fluid catalytic cracking units	*480*	*318*	*330*	*212*	*202*	*195*	*183*	*182*	*185*	*183*	*188*	*188*	*153*	*159*	*158*
other	*290*	*236*	*247*	*88*	*81*	*77*	*121*	*92*	*130*	*95*	*88*	*83*	*81*	*83*	*83*
Asphalt Manufacturing	NA	NA	NA	1	1	1	4	7	7	7	8	9	8	8	8
OTHER INDUSTRIAL PROCESSES	***846***	***740***	***918***	***425***	***411***	***405***	***399***	***396***	***396***	***392***	***398***	***403***	***350***	***365***	***370***
Agriculture, Food, & Kindred Products	NA	NA	NA	3	3	3	3	3	3	3	3	3	4	4	4
Textiles, Leather, & Apparel Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Wood, Pulp & Paper, & Publishing Products	169	168	223	131	135	136	116	123	119	113	109	114	102	106	108
Rubber & Miscellaneous Plastic Products	NA	NA	NA	1	1	1	0	0	0	0	0	0	0	0	0
Mineral Products	677	571	694	286	268	261	275	267	270	272	282	282	230	241	243
cement mfg	*618*	*511*	*630*	*192*	*177*	*172*	181	165	168	170	167	171	147	155	156
other	*59*	*60*	*64*	*95*	*91*	*89*	94	102	102	102	114	111	83	87	87
Machinery Products	NA	NA	NA	0	0	0	0	0	1	0	1	1	0	0	0
Electronic Equipment	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment													0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	3	3	3	5	3	3	3	3	4	13	13	13

Table A-4 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***1***	***1***	***1***	***0***	***0***	***1***	***1***	***1***	***1***	***1***	***1***	***1***
Degreasing	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Dry Cleaning	NA	NA	NA	NA	NA	NA	NA	NA	0	NA	0	0	0	0	0
Surface Coating	NA	NA	NA	1	1	1	0	0	0	0	0	0	0	0	0
Other Industrial	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***4***	***5***	***5***	***7***	***10***	***9***	***5***	***2***	***2***	***3***	***3***	***3***
Bulk Terminals & Plants	NA	NA	NA	NA	NA	NA	0	1	1	0	0	0	0	0	0
Petroleum & Petroleum Product Storage	NA	NA	NA	0	0	0	5	7	0	0	0	0	0	0	0
Petroleum & Petroleum Product Transport	NA	NA	NA	1	1	1	0	0	0	0	0	0	0	0	0
Service Stations: Stage II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0
Organic Chemical Storage	NA	NA	NA	1	1	1	0	0	0	0	0	0	0	0	0
Organic Chemical Transport	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Inorganic Chemical Storage	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Inorganic Chemical Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	1	2	2	1	1	7	4	1	1	2	2	2
WASTE DISPOSAL & RECYCLING	***8***	***46***	***33***	***34***	***36***	***36***	***42***	***44***	***44***	***71***	***60***	***47***	***41***	***42***	***42***
Incineration	4	29	21	25	28	28	32	32	32	51	42	35	29	29	30
industrial	*NA*	*NA*	*NA*	*10*	*11*	*10*	*5*	*4*	*5*	*25*	*17*	*8*	*6*	*6*	*6*
other	*4*	*29*	*21*	*15*	*17*	*18*	*26*	*28*	*27*	*26*	*26*	*27*	*23*	*23*	*24*
Open Burning	4	17	12	9	8	8	11	11	11	11	11	11	11	11	11
industrial	*NA*	*NA*	*NA*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
other	*4*	*17*	*12*	*8*	*8*	*7*	*10*	*10*	*11*	*11*	*11*	*11*	*11*	*11*	*11*
POTW	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Industrial Waste Water	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
TSDF	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Landfills	NA	NA	NA	0	0	0	0	0	0	0	0	0	1	1	1
industrial	*NA*	*NA*	*NA*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
other	*NA*	*NA*	*NA*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other	NA	NA	NA	0	0	0	0	1	1	8	6	0	0	0	0
ON-ROAD VEHICLES	***411***	***503***	***521***	***522***	***553***	***570***	***542***	***570***	***578***	***517***	***301***	***304***	***316***	***322***	***326***
Light-Duty Gas Vehicles & Motorcycles	132	158	159	146	144	145	138	143	146	147	141	143	127	128	130
light-duty gas vehicles	*132*	*158*	*158*	*145*	*144*	*145*	NA	NA	NA	NA	NA	NA	*127*	*127*	*130*
motorcycles	*0*	*0*	*0*	*0*	*0*	*0*	NA	NA	NA	NA	NA	NA	*0*	*0*	*0*
Light-Duty Gas Trucks	40	48	50	55	58	58	57	59	59	60	70	71	95	97	99
light-duty gas trucks 1	*26*	*32*	*33*	*36*	*37*	*38*	NA	NA	NA	NA	NA	NA	*62*	*64*	*65*
light-duty gas trucks 2	*13*	*16*	*16*	*19*	*21*	*21*	NA	NA	NA	NA	NA	NA	*33*	*34*	*34*
Heavy-Duty Gas Vehicles	8	9	10	11	11	11	11	10	10	11	12	11	11	11	11
Diesels	231	288	303	311	340	356	337	358	363	299	79	80	83	85	85

Table A-4 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
NON-ROAD ENGINES AND VEHICLES	***83***	***99***	***175***	***637***	***744***	***779***	***916***	***944***	***968***	***972***	***990***	***999***	***1,016***	***1,050***	***1,084***
Non-Road Gasoline	NA	NA	NA	20	21	22	22	22	22	23	23	23	23	23	23
Non-Road Diesel	NA	NA	NA	407	468	488	509	529	549	570	590	610	631	651	671
Aircraft	4	4	6	6	7	7	11	11	11	11	11	11	11	11	11
Marine Vessels	43	52	117	143	181	193	251	259	258	249	252	239	237	247	261
Railroads	36	43	53	59	65	67	122	120	125	117	113	113	111	115	114
Non-Road Other	NA	NA	NA	1	2	2	2	2	2	2	2	2	2	2	3
MISCELLANEOUS	***110***	***20***	***11***	***11***	***27***	***11***	***12***	***11***	***10***	***10***	***15***	***10***	***17***	***16***	***12***
Agriculture & Forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
Other Combustion	110	20	11	11	27	11	12	11	9	9	15	10	17	15	12
Fugitive Dust	NA	NA	NA	NA	NA	NA	0	0	0	1	0	0	0	0	0
TOTAL ALL SOURCES	31,161	28,011	25,905	23,658	23,135	23,293	23,660	23,041	22,806	22,466	21,870	19,181	19,121	19,622	19,647

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

The 1985 fuel combustion, electric utility category is based on the National Allowance Data Base Version 2.11, Acid Rain Division, U.S. EPA, released March 23, 1993. Allocations at the Tier 3 levels are approximations only and are based on the methodology described in section 6.0, paragraph 6.2.1.1.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

Table A-5. Directly Emitted Particulate Matter (PM_{10}) Emissions (thousand short tons)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	***1,775***	***1,191***	***879***	***280***	***276***	***271***	***295***	***257***	***257***	***279***	***273***	***268***	***287***	***293***	***302***
Coal	1,680	1,091	796	268	261	255	265	232	234	253	246	244	264	268	273
bituminous	*1,041*	*661*	*483*	*217*	*190*	*193*	*188*	*169*	*167*	*185*	*181*	*174*	*195*	*196*	*200*
subbituminous	*513*	*326*	*238*	*35*	*49*	*39*	*37*	*39*	*43*	*46*	*44*	*48*	*50*	*51*	*52*
anthracite & lignite	*126*	*104*	*75*	*16*	*22*	*22*	*41*	*23*	*23*	*22*	*21*	*21*	*19*	*21*	*21*
other	*NA*	*NA*	*NA*	*0*	*0*	*0*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Oil	89	93	76	8	11	12	9	10	7	9	8	5	5	6	9
residual	*85*	*87*	*74*	*8*	*10*	*11*	*9*	*10*	*7*	*9*	*8*	*5*	*5*	*6*	*9*
distillate	*3*	*6*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Gas	7	6	7	1	1	1	1	1	0	1	1	1	1	1	1
Internal Combustion	NA	NA	NA	3	3	3	20	15	16	17	17	18	18	18	19
FUEL COMB. INDUSTRIAL	***641***	***564***	***679***	***247***	***244***	***243***	***270***	***233***	***243***	***257***	***270***	***302***	***255***	***249***	***245***
Coal	83	23	18	71	70	70	84	72	74	71	70	70	74	74	72
bituminous	*52*	*14*	*12*	*48*	*49*	*49*	*59*	*48*	*53*	*51*	*49*	*49*	*44*	*44*	*43*
subbituminous	*16*	*4*	*4*	*1*	*1*	*1*	*5*	*3*	*3*	*3*	*5*	*5*	*5*	*5*	*5*
anthracite & lignite	*15*	*4*	*2*	*7*	*6*	*6*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
other	*NA*	*NA*	*NA*	*15*	*14*	*14*	*19*	*19*	*17*	*16*	*16*	*15*	*24*	*23*	*23*
Oil	89	69	67	52	48	48	52	44	45	45	44	49	46	43	42
residual	*83*	*62*	*63*	*43*	*38*	*39*	*44*	*36*	*37*	*38*	*37*	*42*	*38*	*35*	*34*
distillate	*6*	*7*	*4*	*5*	*5*	*5*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*7*	*6*
other	*0*	*0*	*0*	*4*	*4*	*4*	*2*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Gas	27	25	23	47	45	44	41	34	40	43	43	45	43	42	42
natural	*24*	*22*	*20*	*24*	*24*	*24*	*30*	*24*	*26*	*29*	*30*	*30*	*28*	*27*	*27*
process	*4*	*3*	*3*	*22*	*20*	*20*	*11*	*10*	*13*	*13*	*14*	*15*	*15*	*15*	*15*
other	*NA*	*NA*	*NA*	*1*	*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other	441	447	571	75	79	78	87	72	74	86	74	73	77	73	74
wood/bark waste	*415*	*444*	*566*	*67*	*71*	*71*	*80*	*67*	*67*	*71*	*68*	*68*	*70*	*67*	*68*
liquid waste	*NA*	*NA*	*NA*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
other	*26*	*3*	*5*	*6*	*6*	*6*	*6*	*5*	*6*	*14*	*6*	*5*	*6*	*6*	*6*
Internal Combustion	NA	NA	NA	3	3	3	6	10	11	12	38	64	16	16	15
FUEL COMB. OTHER	***455***	***492***	***887***	***1,009***	***862***	***869***	***631***	***657***	***683***	***588***	***570***	***610***	***632***	***548***	***544***
Commercial/Institutional Coal	13	10	8	13	14	13	15	14	15	15	15	16	15	16	17
Commercial/Institutional Oil	52	34	30	12	15	13	13	11	12	11	12	12	11	12	10
Commercial/Institutional Gas	4	4	4	4	5	5	5	6	6	6	7	6	8	8	8
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	3	3	3	79	73	73	72	73	73	72	75	78
Residential Wood	384	407	818	959	807	817	501	535	558	464	446	484	503	415	411
fireplaces	*384*	*407*	*818*	*959*	*807*	*817*	*501*	*535*	*558*	*464*	*446*	*484*	*429*	*344*	*344*
woodstoves	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*38*	*36*	*34*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*37*	*35*	*33*
Residential Other	3	37	27	18	19	18	18	18	18	18	18	18	23	22	21

Table A-5 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
CHEMICAL & ALLIED PRODUCT MFG	***235***	***127***	***148***	***58***	***62***	***63***	***77***	***68***	***71***	***66***	***76***	***67***	***63***	***64***	***65***
Organic Chemical Mfg	43	21	19	19	21	22	26	28	28	28	29	29	29	29	30
Inorganic Chemical Mfg	61	31	25	7	8	8	19	4	5	5	5	5	4	4	4
Polymer & Resin Mfg	NA	NA	NA	4	5	5	5	4	5	4	4	4	3	3	3
Agricultural Chemical Mfg	46	38	61	9	9	10	11	11	11	11	10	10	9	9	10
Paint, Varnish, Lacquer, Enamel Mfg	NA	NA	NA	0	0	0	1	1	1	1	1	1	1	1	1
Pharmaceutical Mfg	NA	NA	NA	0	0	0	1	0	0	0	0	0	0	0	0
Other Chemical Mfg	86	37	42	18	18	18	14	20	20	18	27	18	18	18	18
METALS PROCESSING	***1,316***	***825***	***622***	***220***	***208***	***211***	***214***	***251***	***250***	***181***	***184***	***212***	***164***	***171***	***171***
Nonferrous Metals Processing	593	229	130	46	45	45	50	46	47	40	39	41	35	37	37
copper	*343*	*66*	*32*	*3*	*3*	*3*	*14*	*14*	*15*	*12*	*11*	*12*	*7*	*7*	*7*
lead	*53*	*31*	*18*	*4*	*3*	*3*	*3*	*2*	*2*	*2*	*2*	*3*	*1*	*1*	*1*
zinc	*20*	*11*	*3*	*3*	*3*	*3*	*6*	*6*	*6*	*1*	*2*	*2*	*1*	*1*	*1*
other	*177*	*121*	*77*	*36*	*36*	*36*	*27*	*23*	*23*	*25*	*25*	*25*	*26*	*27*	*27*
Ferrous Metals Processing	198	275	322	164	153	156	155	123	115	121	125	149	108	113	112
primary	*31*	*198*	*271*	*136*	*126*	*129*	*128*	*99*	*92*	*97*	*100*	*123*	*86*	*91*	*91*
secondary	*167*	*77*	*51*	*26*	*26*	*26*	*25*	*24*	*23*	*24*	*25*	*26*	*21*	*22*	*21*
other	*NA*	*NA*	*NA*	*2*	*2*	*2*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Metals Processing NEC	525	321	170	10	10	10	9	82	88	20	20	22	21	22	22
PETROLEUM & RELATED INDUSTRIES	***286***	***179***	***138***	***63***	***60***	***58***	***55***	***43***	***43***	***38***	***38***	***40***	***32***	***32***	***32***
Oil & Gas Production	NA	NA	NA	0	0	0	2	2	2	2	2	2	1	1	1
Petroleum Refineries & Related Industries	69	56	41	28	25	24	20	20	21	20	19	20	17	18	18
fluid catalytic cracking units	*69*	*56*	*41*	*24*	*22*	*21*	*17*	*17*	*18*	*17*	*16*	*18*	*12*	*12*	*12*
other	*NA*	*NA*	*NA*	*4*	*4*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*5*	*5*	*5*
Asphalt Manufacturing	217	123	97	35	35	34	33	21	20	17	17	18	13	13	13
OTHER INDUSTRIAL PROCESSES	***5,832***	***2,572***	***1,846***	***611***	***601***	***591***	***583***	***520***	***506***	***501***	***495***	***511***	***327***	***337***	***339***
Agriculture, Food, & Kindred Products	485	429	402	68	73	72	73	80	69	73	73	80	61	63	61
country elevators	*257*	*247*	*258*	*7*	*9*	*9*	*9*	*10*	*10*	*10*	*9*	*9*	*6*	*6*	*6*
terminal elevators	*147*	*111*	*86*	*6*	*6*	*6*	*6*	*7*	*8*	*8*	*7*	*7*	*2*	*2*	*2*
feed mills	*5*	*3*	*3*	*6*	*7*	*7*	*7*	*4*	*5*	*5*	*5*	*5*	*4*	*4*	*4*
soybean mills	*25*	*27*	*22*	*13*	*14*	*14*	*14*	*15*	*11*	*12*	*12*	*12*	*6*	*7*	*7*
wheat mills	*5*	*1*	*1*	*3*	*4*	*3*	*3*	*4*	*4*	*4*	*4*	*4*	*1*	*2*	*2*
other grain mills	*9*	*8*	*6*	*7*	*8*	*8*	*8*	*6*	*5*	*6*	*6*	*7*	*6*	*6*	*6*
other	*38*	*32*	*26*	*25*	*26*	*25*	*25*	*34*	*26*	*28*	*30*	*37*	*36*	*36*	*34*
Textiles, Leather, & Apparel Products	NA	NA	NA	0	0	0	0	0	0	0	0	0	1	1	1

Table A-5 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
OTHER INDUSTRIAL PROCESSES (continued)															
Wood, Pulp & Paper, & Publishing Products	727	274	183	101	108	106	105	81	79	78	76	81	78	81	82
sulfate (kraft) pulping	*668*	*228*	*142*	*71*	*73*	*74*	*73*	*53*	*50*	*49*	*50*	*53*	*43*	*44*	*45*
other	*59*	*46*	*41*	*30*	*34*	*33*	*32*	*27*	*29*	*29*	*26*	*28*	*35*	*36*	*37*
Rubber & Miscellaneous Plastic Products	NA	NA	NA	3	4	4	4	4	4	3	3	3	4	4	4
Mineral Products	4,620	1,869	1,261	401	382	374	367	320	318	316	313	317	156	161	162
cement mfg	*1,731*	*703*	*417*	*213*	*198*	*193*	*190*	*147*	*145*	*140*	*139*	*140*	*21*	*22*	*22*
surface mining	*134*	*111*	*127*	*20*	*16*	*15*	*15*	*14*	*15*	*17*	*17*	*17*	*14*	*15*	*15*
stone quarrying/processing	*957*	*508*	*421*	*52*	*56*	*54*	*54*	*59*	*60*	*60*	*58*	*58*	*24*	*24*	*24*
other	*1,798*	*547*	*296*	*116*	*113*	*111*	*108*	*99*	*98*	*99*	*100*	*102*	*97*	*100*	*101*
Machinery Products	NA	NA	NA	8	9	9	9	8	9	7	7	7	8	8	8
Electronic Equipment	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	NA	NA	NA	2	2	2	2	2	2	0	0	0	0	0	0
Construction	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	NA	NA	NA	28	24	23	23	25	24	22	22	23	20	20	21
SOLVENT UTILIZATION	***NA***	***NA***	***NA***	***2***	***2***	***2***	***4***	***5***	***5***	***6***	***6***	***6***	***6***	***6***	***6***
Degreasing	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Graphic Arts	NA	NA	NA	0	0	0	0	0	0	0	0	0	1	1	1
Dry Cleaning	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Surface Coating	NA	NA	NA	2	2	2	3	4	4	5	5	5	4	5	5
Other Industrial	NA	NA	NA	0	0	0	1	1	1	1	1	1	0	0	0
Nonindustrial	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
Solvent Utilization NEC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0
STORAGE & TRANSPORT	***NA***	***NA***	***NA***	***107***	***101***	***101***	***102***	***101***	***117***	***114***	***106***	***109***	***90***	***93***	***94***
Bulk Terminals & Plants	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Storage	NA	NA	NA	0	0	0	0	1	1	1	0	0	0	1	1
Petroleum & Petroleum Product Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Service Stations: Stage II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0
Organic Chemical Storage	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	1
Organic Chemical Transport	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
Inorganic Chemical Storage	NA	NA	NA	0	0	0	1	1	1	1	1	1	0	0	1
Inorganic Chemical Transport	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	NA	NA	NA	105	99	99	100	99	115	111	104	107	87	90	91
storage	*NA*	*NA*	*NA*	*33*	*32*	*31*	*31*	*27*	*30*	*32*	*31*	*30*	*25*	*25*	*25*
transfer	*NA*	*NA*	*NA*	*72*	*66*	*67*	*69*	*71*	*85*	*79*	*73*	*76*	*62*	*65*	*65*
combined	*NA*	*NA*	*NA*	*1*	*1*	*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*0*	*0*	*NA*	*0*	*0*	*0*	*0*	*0*
Bulk Materials Transport	NA	NA	NA	0	0	0	1	0	0	0	0	0	0	0	0

Table A-5 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
WASTE DISPOSAL & RECYCLING	999	371	273	278	259	251	271	276	278	334	313	287	304	307	310
Incineration	229	95	75	52	51	50	65	66	65	119	96	69	89	90	91
residential	51	49	42	39	36	35	39	41	43	44	45	45	62	63	63
other	178	46	32	13	15	15	26	25	23	74	52	25	27	28	28
Open Burning	770	276	198	225	208	200	206	209	211	214	216	217	211	213	215
residential	770	276	198	221	203	195	195	197	199	202	203	204	194	195	197
other	NA	NA	NA	4	5	5	11	12	12	13	13	13	17	18	18
POTW	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Industrial Waste Water	NA	NA	NA	0	0	0	NA	0	0	0	0	0	0	0	0
TSDF	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0	0
Landfills	NA	NA	NA	0	0	0	0	0	1	1	1	0	2	2	3
Other	NA	NA	NA	0	0	0	0	0	0	0	1	1	1	1	1
ON-ROAD VEHICLES	443	471	397	363	369	367	336	349	343	321	320	293	282	272	257
Light-Duty Gas Vehicles & Motorcycles	225	207	120	77	66	65	61	63	64	65	62	62	55	56	56
light-duty gas vehicles	224	206	119	77	66	64	61	63	63	64	61	62	55	55	56
motorcycles	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Light-Duty Gas Trucks	70	72	55	43	37	34	30	32	31	31	35	32	41	41	40
light-duty gas trucks 1	41	39	25	19	16	16	16	15	15	15	17	17	23	23	24
light-duty gas trucks 2	29	34	29	24	20	19	14	17	17	16	18	14	18	17	17
Heavy-Duty Gas Vehicles	13	15	15	14	12	11	10	10	9	10	10	9	9	9	8
Diesels	136	177	208	229	254	257	235	245	239	215	213	190	177	167	152
heavy-duty diesel vehicles	136	166	194	219	244	247	224	234	228	205	204	181	168	158	144
light-duty diesel trucks	NA	NA	2	1	2	2	1	2	2	2	2	2	2	2	2
light-duty diesel vehicles	NA	10	12	8	9	9	9	9	9	8	8	8	7	6	6
NON-ROAD ENGINES AND VEHICLES	220	310	398	424	473	477	489	489	490	483	480	456	457	458	461
Non-Road Gasoline	12	39	42	44	46	46	47	47	48	48	48	49	49	49	48
recreational	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
construction	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
industrial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lawn & garden	8	8	9	9	10	10	11	11	11	12	12	12	12	12	11
farm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
light commercial	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
logging	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
airport service	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
railway maintenance	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
recreational marine vessels (other)	UA	26	28	29	30	30	30	30	30	30	30	30	30	30	30

Table A-5 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
NON-ROAD ENGINES AND VEHICLES (continued)															
Non-Road Diesel	154	204	263	272	303	302	301	299	297	296	296	296	297	299	301
recreational	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
construction	75	92	123	134	149	149	149	148	147	147	146	146	147	148	150
industrial	36	23	27	35	39	38	38	37	37	38	38	38	39	40	41
lawn & garden	3	3	4	4	7	8	8	9	10	11	11	12	13	14	14
farm	16	66	85	70	78	78	78	77	76	75	74	73	72	70	69
light commercial	6	7	7	9	11	11	12	12	12	13	13	14	14	14	15
logging	17	12	16	19	17	15	13	11	10	9	9	8	8	8	8
airport service	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
railway maintenance	NA	UA	UA	0	1	1	1	1	1	1	1	1	1	1	1
recreational marine vessels	NA	UA	UA	1	1	1	1	1	1	1	2	2	2	2	2
Aircraft	21	26	33	37	42	43	44	44	45	43	41	40	40	39	39
Marine Vessels	9	10	23	28	35	38	44	46	45	43	44	43	43	44	44
coal	1	1	2	2	3	3	3	3	3	3	3	3	3	3	3
diesel	5	6	15	17	22	23	27	28	27	26	26	26	40	40	41
residual oil	3	3	7	9	11	12	14	14	14	14	14	13	0	0	0
gasoline	NA	NA	NA	NA	NA	NA	1	1	1	1	1	1	1	1	1
Railroads	25	30	37	41	45	47	53	53	54	52	50	27	27	27	27
Non-Road Other	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
liquified petroleum gas	NA	NA	NA	1	1	1	1	1	1	1	1	1	1	1	1
compressed natural gas	NA	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0
NATURAL SOURCES	***NA***	***NA***	***NA***	***4,047***	***18,110***	***12,101***	***2,092***	***2,077***	***2,227***	***509***	***2,160***	***1,146***	***5,307***	***5,307***	***5,307***
Geogenic	NA	NA	NA	4,047	18,110	12,101	2,092	2,077	2,227	509	2,160	1,146	5,307	5,307	5,307
*wind erosion**	NA	NA	NA	4,047	18,110	12,101	2,092	2,077	2,227	509	2,160	1,146	5,307	5,307	5,307
MISCELLANEOUS	***839***	***569***	***852***	***37,736***	***39,444***	***37,461***	***24,542***	***24,234***	***23,959***	***24,329***	***25,620***	***22,766***	***24,836***	***26,089***	***26,609***
Agriculture & Forestry	NA	NA	NA	7,108	7,453	7,320	5,292	5,234	5,017	4,575	4,845	4,902	4,905	4,971	4,970
*agricultural crops***	NA	NA	NA	6,833	7,077	6,923	4,745	4,684	4,464	4,016	4,281	4,334	4,328	4,373	4,366
*agricultural livestock***	NA	NA	NA	275	376	396	547	550	553	558	564	569	577	598	603
Other Combustion	839	569	852	894	1,704	912	1,181	924	770	801	1,053	850	1,254	1,313	1,018
Cooling Towers	NA	NA	NA	NA	NA	NA	0	0	0	0	0	1	2	2	2

Table A-5 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
MISCELLANEOUS (continued)															
Fugitive Dust	NA	NA	NA	29,734	30,287	29,229	18,069	18,076	18,171	18,954	19,722	17,013	18,675	19,804	20,619
*unpaved roads***	*NA*	*NA*	*NA*	*11,644*	*12,379*	*11,798*	*11,234*	*11,206*	*10,918*	*11,430*	*11,370*	*10,362*	*12,059*	*12,530*	*12,668*
*paved roads***	*NA*	*NA*	*NA*	*5,080*	*5,900*	*5,769*	*2,248*	*2,399*	*2,423*	*2,462*	*2,538*	*2,409*	*2,390*	*2,538*	*2,618*
*construction***	*NA*	*NA*	*NA*	*12,670*	*11,662*	*11,269*	*4,249*	*4,092*	*4,460*	*4,651*	*5,245*	*3,654*	*3,578*	*4,022*	*4,545*
other	*NA*	*NA*	*NA*	*339*	*346*	*392*	*336*	*377*	*369*	*409*	*569*	*586*	*646*	*713*	*788*
TOTAL ALL SOURCES	**13,042**	**7,671**	**7,119**	**45,445**	**61,072**	**53,064**	**29,962**	**29,560**	**29,472**	**28,006**	**30,913**	**27,070**	**33,041**	**34,226**	**34,741**

Note(s): NA = not available. For several source categories, emissions either prior to or beginning with 1985 are not available at the more detailed level but are contained in the more aggregate estimate.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

No data was available after 1984 to weigh the emissions from residential wood burning devices.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

* Although geogenic wind erosion emissions are included in this summary table, it is very difficult to interpret annual estimates of PM emissions from this source category in a meaningful way, owing to the highly episodic nature of the events that contribute to these emissions.

** These are the main source categories of PM crustal material emissions. A report by the Desert Research Institute found that about 75% of these emissions are within 2 m of the ground at the point they are measured. Thus, most of them are likely to be removed or deposited within a few km of their release, depending on atmospheric turbulence, temperature, soil moisture, availability of horizontal and vertical surfaces for impaction and initial suspension energy. This is consistent with the generally small amount of crustal materials found on speciated ambient samples. (See reference 6 in Chapter 2.)

Table A-6. Directly Emitted Particulate Matter ($PM_{2.5}$) Emissions (thousand short tons)

SOURCE CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	***121***	***105***	***106***	***112***	***108***	***107***	***156***	***160***	***165***
Coal	97	85	87	90	86	86	133	135	138
bituminous	*59*	*53*	*53*	*57*	*54*	*52*	*88*	*89*	*91*
subbituminous	*14*	*16*	*18*	*18*	*17*	*20*	*32*	*31*	*32*
anthracite & lignite	*23*	*16*	*16*	*15*	*15*	*15*	*13*	*15*	*15*
Oil	5	5	4	5	5	3	4	5	8
Gas	NA	NA	NA	NA	NA	NA	1	1	1
Internal Combustion	20	15	16	17	17	18	18	18	19
FUEL COMB. INDUSTRIAL	***177***	***151***	***159***	***172***	***183***	***203***	***166***	***161***	***160***
Coal	29	23	25	24	25	25	24	24	24
bituminous	*23*	*18*	*20*	*20*	*19*	*19*	*19*	*19*	*18*
subbituminous	*2*	*1*	*1*	*2*	*3*	*3*	*3*	*3*	*3*
anthracite & lignite	*1*	*1*	*0*	*0*	*0*	*1*	*0*	*0*	*0*
other	*3*	*3*	*3*	*3*	*2*	*2*	*2*	*2*	*2*
Oil	31	26	26	27	26	28	26	24	23
residual	*26*	*22*	*22*	*23*	*22*	*24*	*22*	20	19
distillate	*4*	*3*	*3*	*4*	*4*	*4*	*4*	*4*	*4*
other	*1*	*1*	*1*	*1*	*1*	*1*	*0*	*1*	*0*
Gas	39	34	39	41	42	44	39	39	39
natural	*29*	*23*	*26*	*28*	*29*	*29*	*25*	25	25
process	*11*	*10*	*13*	*13*	*14*	*15*	*14*	*14*	*14*
other	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Other	73	58	59	69	60	59	62	60	60
wood/bark waste	*68*	*55*	*54*	*58*	*55*	*55*	*57*	*55*	*55*
liquid waste	*1*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*
other	*4*	*3*	*4*	*10*	*4*	*3*	*5*	*5*	*5*
Internal Combustion	5	10	10	11	29	48	14	14	14
FUEL COMB. OTHER	***611***	***638***	***662***	***568***	***550***	***589***	***537***	***466***	***466***
Commercial/Institutional Coal	6	6	6	6	6	6	6	6	7
Commercial/Institutional Oil	5	5	5	5	5	5	5	5	4
Commercial/Institutional Gas	5	5	6	6	6	6	7	7	7
Misc. Fuel Comb. (Except Residential)	78	73	72	72	72	73	71	75	78
Residential Wood	501	535	558	464	446	484	433	358	357
fireplaces	501	535	558	464	446	484	418	344	344
woodstoves	NA	NA	NA	NA	NA	NA	15	14	13
Residential Other	15	15	15	15	15	15	15	14	13

Table A-6 (continued)

SOURCE CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998
CHEMICAL & ALLIED PRODUCT MFG	***47***	***43***	***45***	***41***	***49***	***42***	***38***	***39***	***39***
Organic Chemical Mfg	10	10	11	10	11	11	11	11	12
Inorganic Chemical Mfg	12	3	4	4	4	3	3	3	3
Polymer & Resin Mfg	4	3	4	3	3	3	2	2	2
Agricultural Chemical Mfg	8	8	8	8	8	8	6	6	7
Paint, Varnish, Lacquer, Enamel Mfg	0	0	0	0	0	0	0	0	0
Pharmaceutical Mfg	0	0	0	0	0	0	0	0	0
Other Chemical Mfg	13	17	17	15	23	16	16	16	16
METALS PROCESSING	***157***	***197***	***198***	***125***	***125***	***134***	***108***	***113***	***112***
Nonferrous Metals Processing	31	29	29	25	25	25	24	25	25
copper	*9*	*9*	*9*	*8*	*8*	*8*	*6*	*6*	*6*
lead	*2*	*2*	*2*	*2*	*2*	*2*	*1*	*1*	*1*
zinc	*5*	*5*	*5*	*1*	*1*	*1*	*1*	*1*	*1*
other	*14*	*13*	*13*	*14*	*14*	*14*	*16*	*16*	*16*
Ferrous Metals Processing	121	89	83	86	86	92	69	72	72
primary	*103*	*72*	*66*	*68*	*68*	*74*	*53*	*56*	*56*
secondary	*17*	*16*	*16*	*17*	*18*	*19*	*16*	*16*	*16*
other	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Metals Processing NEC	5	80	85	14	14	16	15	16	16
PETROLEUM & RELATED INDUSTRIES	***27***	***24***	***24***	***22***	***22***	***22***	***18***	***18***	***18***
Oil & Gas Production	2	2	2	2	2	2	1	1	1
Petroleum Refineries & Related Industries	13	14	14	13	13	13	11	12	12
fluid catalytic cracking units	*11*	*12*	*12*	*11*	*11*	*11*	*8*	*8*	*8*
other	*2*	*2*	*2*	*2*	*2*	*2*	*4*	*4*	*4*
Asphalt Manufacturing	12	9	8	7	7	8	6	6	5
OTHER INDUSTRIAL PROCESSES	***284***	***264***	***259***	***260***	***256***	***256***	***178***	***184***	***187***
Agriculture, Food, & Kindred Products	39	46	40	44	43	40	21	22	22
country elevators	*6*	*6*	*7*	*6*	*6*	*6*	*1*	*1*	*1*
terminal elevators	*3*	*3*	*4*	*5*	*4*	*4*	*0*	*0*	*0*
feed mills	*2*	*2*	*2*	*2*	*2*	*2*	*1*	*1*	*1*
soybean mills	*5*	*4*	*4*	*5*	*5*	*5*	*2*	*3*	*3*
wheat mills	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
other grain mills	*4*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
other	*17*	*26*	*19*	*21*	*22*	*20*	*14*	*14*	*14*
Textiles, Leather, & Apparel Products	0	0	0	0	0	0	1	1	1
Wood, Pulp & Paper, & Publishing Products	77	61	59	59	57	60	54	56	57
sulfate (kraft) pulping	*57*	*40*	*38*	*38*	*38*	*40*	*34*	*35*	*35*
other	*21*	*21*	*21*	*21*	*19*	*20*	*21*	*21*	*22*

Table A-6 (continued)

SOURCE CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998
OTHER INDUSTRIAL PROCESSES (continued)									
Rubber & Miscellaneous Plastic Products	3	3	3	3	3	3	2	2	2
Mineral Products	144	134	135	136	133	134	83	87	88
cement mfg	*54*	*40*	*39*	*38*	*38*	*38*	*9*	*10*	*10*
surface mining	*6*	*6*	*7*	*7*	*7*	*6*	*6*	*6*	*6*
stone quarrying/processing	*24*	*28*	*28*	*28*	*26*	*26*	*9*	*9*	*9*
other	*61*	*60*	*61*	*62*	*63*	*63*	*60*	*62*	*63*
Machinery Products	3	3	3	3	3	3	3	3	3
Electronic Equipment	0	0	0	0	0	0	0	0	0
Transportation Equipment	1	1	1	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0
Miscellaneous Industrial Processes	16	16	17	15	16	16	13	13	14
SOLVENT UTILIZATION	***4***	***4***	***5***	***6***	***6***	***5***	***5***	***5***	***5***
Degreasing	0	0	0	0	0	0	0	0	0
Graphic Arts	0	0	0	0	0	0	1	1	1
Dry Cleaning	0	0	0	0	0	0	0	0	0
Surface Coating	3	3	4	4	4	4	4	4	4
Other Industrial	1	1	1	1	1	1	0	0	0
Nonindustrial	NA	NA	NA	NA	NA	NA	0	0	0
Solvent Utilization NEC	NA	NA	NA	NA	NA	NA	0	0	0
STORAGE & TRANSPORT	***42***	***42***	***50***	***46***	***43***	***42***	***31***	***32***	***32***
Bulk Terminals & Plants	0	0	0	0	0	0	0	0	0
Petroleum & Petroleum Product Storage	0	1	1	1	0	0	0	0	0
Petroleum & Petroleum Product Transport	0	0	0	0	0	0	0	0	0
Service Stations: Stage II	0	0	0	0	0	0	0	0	0
Organic Chemical Storage	0	0	0	0	0	0	1	1	1
Organic Chemical Transport	0	0	0	0	0	0	0	0	0
Inorganic Chemical Storage	0	0	0	0	0	0	0	0	0
Inorganic Chemical Transport	0	0	0	0	0	0	0	0	0
Bulk Materials Storage	41	41	48	44	41	41	29	30	30
storage	*13*	*11*	*12*	*13*	*13*	*12*	*10*	*10*	*10*
transfer	*28*	*29*	*36*	*31*	*28*	*29*	*19*	*20*	*20*
combined	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
other	*NA*	*0*	*0*	*NA*	*0*	*0*	*0*	*0*	*0*
Bulk Materials Transport	0	0	0	0	0	0	0	0	0

Table A-6 (continued)

SOURCE CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998
WASTE DISPOSAL & RECYCLING	*234*	*238*	*239*	*288*	*271*	*247*	*234*	*236*	*238*
Incineration	46	47	46	93	73	50	45	46	46
residential	*27*	*28*	*30*	*31*	*31*	*31*	*30*	*30*	*30*
other	*19*	*18*	*16*	*62*	*42*	*19*	*15*	*15*	*16*
Open Burning	187	190	192	195	196	197	186	188	190
residential	*177*	*179*	*181*	*183*	*184*	*185*	*176*	*177*	*179*
other	*10*	*11*	*11*	*11*	*12*	*11*	*10*	*11*	*11*
POTW	0	0	0	0	0	0	0	0	0
Industrial Waste Water	0	0	0	0	0	0	0	0	0
TSDF	0	0	0	0	0	0	0	0	0
Landfills	0	0	1	1	1	0	2	2	2
Other	0	0	0	0	1	0	1	1	1
ON-ROAD VEHICLES	*275*	*286*	*280*	*257*	*256*	*231*	*221*	*211*	*197*
Light-Duty Gas Vehicles & Motorcycles	37	38	38	38	36	36	32	32	33
ldgv	*37*	*38*	*37*	*38*	*36*	*36*	*32*	*32*	*32*
motorcycles	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Light-Duty Gas Trucks	19	21	20	20	23	20	25	25	25
ldgt1	*10*	*10*	*9*	*9*	*11*	*11*	*14*	*14*	*15*
ldgt2	*9*	*11*	*11*	*10*	*12*	*9*	*11*	*11*	*11*
Heavy-Duty Gas Vehicles	7	6	6	7	7	6	6	6	5
Diesels	212	221	216	192	190	169	157	147	134
hddv	*203*	*212*	*206*	*183*	*182*	*161*	*149*	*140*	*127*
lddt	*1*	*1*	*2*	*1*	*2*	*2*	*2*	*2*	*2*
lddv	*8*	*8*	*8*	*7*	*7*	*7*	*6*	*6*	*5*
NON-ROAD ENGINES AND VEHICLES	*432*	*432*	*433*	*427*	*424*	*403*	*410*	*411*	*413*
Non-Road Gasoline	43	43	43	44	44	45	45	44	44
recreational	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
construction	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
industrial	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
lawn & garden	*10*	*10*	*10*	*11*	*11*	*11*	*11*	*11*	*10*
farm	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
light commercial	*1*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
logging	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
airport service	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
railway maintenance	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
recreational marine vessels	*27*	*27*	*27*	*28*	*28*	*28*	*28*	*28*	*28*

Table A-6 (continued)

SOURCE CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998
NON-ROAD ENGINES AND VEHICLES (continued)									
Non-Road Diesel	277	275	273	273	272	272	274	275	277
recreational	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
construction	*137*	*136*	*136*	*135*	*134*	*134*	*135*	*136*	*138*
industrial	*35*	*34*	*34*	*35*	*35*	*35*	*36*	*37*	*38*
lawn & garden	*8*	*8*	*9*	*10*	*11*	*11*	*12*	*13*	*13*
farm	*71*	*71*	*70*	*69*	*68*	*67*	*66*	*65*	*63*
light commercial	*11*	*11*	*11*	*12*	*12*	*13*	*13*	*13*	*13*
logging	*12*	*10*	*9*	*8*	*8*	*8*	*7*	*7*	*7*
airport service	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
railway maintenance	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
recreational marine vessels	*1*	*1*	*1*	*1*	*1*	*1*	*2*	*2*	*2*
Aircraft	31	31	32	30	29	28	28	27	27
Marine Vessels	32	34	33	31	32	31	38	38	39
coal	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
diesel	*25*	*26*	*25*	*24*	*24*	*24*	*36*	*37*	*37*
residual oil	*6*	*6*	*6*	*6*	*6*	*6*	*0*	*0*	*0*
gasoline	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Railroads	49	48	50	48	46	25	24	25	25
Non-Road Other	1	1	1	1	1	1	1	1	1
liquified petroleum gas	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
compressed natural gas	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
NATURAL SOURCES	***314***	***312***	***334***	***76***	***324***	***172***	***796***	***796***	***796***
Geogenic - wind erosion*	314	312	334	76	324	172	796	796	796
MISCELLANEOUS	***5,234***	***5,004***	***4,854***	***4,926***	***5,360***	***4,725***	***5,298***	***5,652***	***5,549***
Agriculture & Forestry	1,031	1,019	976	887	941	952	952	964	964
*agricultural crops***	*949*	*937*	*893*	*803*	*856*	*867*	*866*	*875*	*873*
*agricultural livestock***	*82*	*83*	*83*	*84*	*85*	*85*	*87*	*90*	*91*
Other Combustion	1,037	807	666	693	913	734	1,040	1,150	882
Cooling Towers	0	0	0	0	0	1	2	2	2
Fugitive Dust	3,166	3,178	3,213	3,346	3,506	3,038	3,304	3,535	3,701
*unpaved roads***	*1,687*	*1,684*	*1,642*	*1,718*	*1,709*	*1,559*	*1,819*	*1,892*	*1,912*
*paved roads***	*562*	*600*	*606*	*616*	*634*	*585*	*598*	*635*	*655*
*construction***	*850*	*818*	*892*	*930*	*1,049*	*777*	*750*	*857*	*968*
other	*67*	*75*	*73*	*81*	*113*	*117*	*137*	*151*	*166*
TOTAL ALL SOURCES	7,958	7,739	7,648	7,327	7,975	7,179	8,194	8,483	8,379

Note(s): NA = not available.
"Other" categories may contain emissions that could not be accurately allocated to specific source categories.
Zero values represent less than 500 short tons/year.
In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

* Although geogenic wind erosion emissions are included in this summary table, it is very difficult to interpret annual estimates of PM emissions from this source category in a meaningful way, owing to the highly episodic nature of the events that contribute to these emissions.

** These are the main source categories of PM crustal material emissions. A report by the Desert Research Institute found that about 75% of these emissions are within 2 m of the ground at the point they are measured. Thus, most of them are likely to be removed or deposited within a few km of their release, depending on atmospheric turbulence, temperature, soil moisture, initial suspension energy and availability of horizontal and vertical surfaces for impaction. This is consistent with the generally small amount of crustal materials found on speciated ambient samples. (See reference 6 in Chapter 2.)

Table A-7. Lead Emissions
(short tons)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	327	230	129	64	66	67	64	61	59	62	62	57	61	64	68
Coal	300	189	95	51	46	46	46	46	47	50	50	50	53	54	54
bituminous	181	114	57	31	28	28	28	28	28	30	30	30	32	33	33
subbituminous	89	56	28	15	14	14	14	14	14	15	15	15	16	16	16
anthracite & lignite	30	19	9	5	4	4	4	4	4	5	5	5	5	5	5
Oil	28	41	34	13	20	21	18	15	12	12	12	7	8	10	14
residual	27	40	34	13	20	21	18	15	12	12	12	7	8	10	14
distillate	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FUEL COMB. INDUSTRIAL	237	75	60	30	19	18	18	18	18	19	19	18	16	16	19
Coal	218	60	45	22	14	14	14	15	14	14	14	14	13	14	13
bituminous	146	40	31	15	10	10	10	10	10	10	10	10	9	9	9
subbituminous	45	12	10	5	3	3	3	3	3	3	3	3	3	3	3
anthracite & lignite	27	7	4	2	1	1	1	1	1	1	1	1	1	1	1
Oil	19	16	14	8	5	4	3	3	4	5	5	4	3	2	5
residual	17	14	14	7	5	3	3	2	3	4	4	3	2	2	5
distillate	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
FUEL COMB. OTHER	10,052	10,042	4,111	421	426	420	418	416	414	416	415	415	415	413	416
Commercial/Institutional Coal	1	16	12	6	5	4	4	3	4	4	3	4	5	5	5
bituminous	1	6	6	4	3	3	3	2	2	2	2	2	3	3	3
subbituminous	NA	2	2	1	1	1	1	1	1	1	1	1	1	1	1
anthracite, lignite	NA	7	4	1	1	1	0	0	0	1	0	1	1	1	2
Commercial/Institutional Oil	4	11	10	4	5	4	4	4	4	4	4	3	3	2	4
residual	3	10	9	3	4	3	3	3	3	3	3	2	2	2	4
distillate	NA	1	1	1	1	1	1	1	1	1	1	1	1	1	1
other	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0
Misc. Fuel Comb. (Except Residential)	10,000	10,000	4,080	400	400	400	400	400	400	400	400	400	400	400	400
Residential Other	47	16	9	11	16	12	10	9	7	8	8	8	7	6	6
CHEMICAL & ALLIED PRODUCT MFG	103	120	104	118	136	136	136	132	93	92	96	163	167	188	175
Inorganic Chemical Mfg	103	120	104	118	136	136	136	132	93	92	96	163	167	188	175
lead oxide and pigments	103	120	104	118	136	136	136	132	93	92	96	163	167	188	175

Table A-7 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
METALS PROCESSING	***24,224***	***9,923***	***3,026***	***2,097***	***1,965***	***2,088***	***2,170***	***1,974***	***1,774***	***1,900***	***2,027***	***2,049***	***2,055***	***2,080***	***2,098***
Nonferrous Metals Processing	15,869	7,192	1,826	1,376	1,248	1,337	1,409	1,258	1,112	1,210	1,287	1,337	1,333	1,341	1,371
primary lead production	*12,134*	*5,640*	*1,075*	*874*	*684*	*715*	*728*	*623*	*550*	*637*	*633*	*674*	*588*	*619*	*628*
primary copper production	*242*	*171*	*20*	*19*	*17*	*19*	*19*	*19*	*20*	*21*	*22*	*21*	*22*	*23*	*23*
primary zinc production	*1,019*	*224*	*24*	*16*	*8*	*9*	*9*	*11*	*11*	*13*	*12*	*12*	*13*	*13*	*13*
secondary lead production	*1,894*	*821*	*481*	*288*	*353*	*433*	*449*	*414*	*336*	*341*	*405*	*432*	*514*	*484*	*505*
secondary copper production	*374*	*200*	*116*	*70*	*61*	*37*	*75*	*65*	*73*	*70*	*76*	*79*	*76*	*82*	*83*
lead battery manufacture	*41*	*49*	*50*	*65*	*73*	*74*	*78*	*77*	*77*	*81*	*94*	*102*	*103*	*107*	*117*
lead cable coating	*127*	*55*	*37*	*43*	*50*	*50*	*50*	*48*	*44*	*47*	*44*	*16*	*16*	*14*	*1*
other	*38*	*32*	*24*	*3*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Ferrous Metals Processing	7,395	2,196	911	577	554	582	576	517	461	496	540	528	529	538	542
coke manufacturing	*11*	*8*	*6*	*3*	*4*	*4*	*4*	*3*	*3*	*2*	*0*	*0*	*0*	*0*	*0*
ferroalloy production	*219*	*104*	*13*	*7*	*14*	*20*	*18*	*14*	*14*	*12*	*13*	*8*	*8*	*8*	*4*
iron production	*266*	*93*	*38*	*21*	*18*	*19*	*18*	*16*	*17*	*18*	*18*	*19*	*18*	*18*	*19*
steel production	*3,125*	*1,082*	*481*	*209*	*157*	*138*	*138*	*145*	*139*	*145*	*160*	*159*	*160*	*165*	*173*
gray iron production	*3,773*	*910*	*373*	*336*	*361*	*401*	*397*	*339*	*288*	*319*	*349*	*342*	*343*	*348*	*345*
Metals Processing NEC	960	535	289	144	164	170	185	199	202	194	200	184	193	201	186
metal mining	*353*	*268*	*207*	*141*	*163*	*169*	*184*	*198*	*201*	*193*	*199*	*183*	*192*	*200*	*186*
other	*606*	*268*	*82*	*3*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
OTHER INDUSTRIAL PROCESSES	***2,028***	***1,337***	***808***	***316***	***172***	***173***	***169***	***167***	***56***	***55***	***54***	***59***	***51***	***54***	***54***
Mineral Products	540	217	93	43	23	23	26	24	26	27	28	29	29	30	31
cement manufacturing	*540*	*217*	*93*	*43*	*23*	*23*	*26*	*24*	*26*	*27*	*28*	*29*	*29*	*30*	*31*
Miscellaneous Industrial Processes	1,488	1,120	715	273	149	150	143	143	30	28	26	30	22	25	23
WASTE DISPOSAL & RECYCLING	***2,200***	***1,595***	***1,210***	***871***	***817***	***765***	***804***	***808***	***812***	***825***	***830***	***604***	***609***	***615***	***620***
Incineration	2,200	1,595	1,210	871	817	765	804	808	812	825	830	604	609	615	620
municipal waste	*581*	*396*	*161*	*79*	*49*	*45*	*67*	*70*	*68*	*69*	*68*	*70*	*76*	*75*	*75*
other	*1,619*	*1,199*	*1,049*	*792*	*768*	*720*	*738*	*738*	*744*	*756*	*762*	*534*	*534*	*540*	*546*
ON-ROAD VEHICLES	***171,961***	***130,206***	***60,501***	***18,052***	***2,566***	***982***	***421***	***18***	***18***	***19***	***19***	***19***	***19***	***20***	***19***
Light-Duty Gas Vehicles & Motorcycles	142,918	106,868	47,184	13,637	1,919	733	314	13	14	14	14	14	12	13	12
Light-Duty Gas Trucks	22,683	19,440	11,671	4,061	605	232	100	4	4	5	5	5	7	7	7
Heavy-Duty Gas Vehicles	6,361	3,898	1,646	354	42	16	7	0	0	0	0	0	0	0	0

Table A-7 (continued)

Source Category	1970	1975	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
NON-ROAD ENGINES AND VEHICLES	***9,737***	***6,130***	***4,205***	***921***	***885***	***820***	***776***	***574***	***565***	***529***	***525***	***544***	***505***	***503***	***503***
Non-Road Gasoline	8,340	5,012	3,320	229	211	166	158	0	0	0	0	0	0	0	0
Aircraft	1,397	1,118	885	692	674	655	619	574	565	528	525	544	505	503	503
TOTAL ALL SOURCES	**220,869**	**159,659**	**74,153**	**22,890**	**7,053**	**5,468**	**4,975**	**4,169**	**3,810**	**3,916**	**4,047**	**3,929**	**3,899**	**3,952**	**3,973**

Note(s): NA=not available

In order to convert emissions to megagrams (metric tons), multiply the above values by 0.9072.

Table A-8. Ammonia (NH_3) Emissions (thousand short tons)

SOURCE CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMB. ELEC. UTIL.	***0***	***0***	***0***	***0***	***0***	***0***	***6***	***7***	***8***
Coal	NA	NA	NA	NA	NA	NA	0	0	0
Oil	NA	NA	NA	NA	NA	NA	2	2	3
Gas	NA	NA	NA	NA	NA	NA	4	4	4
Internal Combustion	0	0	0	0	0	0	0	0	0
FUEL COMB. INDUSTRIAL	***17***	***17***	***17***	***18***	***18***	***18***	***49***	***48***	***47***
Coal	0	0	0	0	0	0	0	0	0
Oil	4	4	4	4	4	4	4	4	4
Gas	13	13	13	14	14	13	39	38	38
Other	0	0	0	0	0	0	1	1	1
Internal Combustion	0	0	0	0	0	0	5	4	4
FUEL COMB. OTHER	***8***	***8***	***8***	***8***	***8***	***8***	***7***	***7***	***6***
Commercial/Institutional Coal	0	0	0	0	0	0	0	0	0
Commercial/Institutional Oil	2	2	2	2	2	2	2	2	2
Commercial/Institutional Gas	1	1	1	1	1	1	1	1	1
Misc. Fuel Comb. (Except Residential)	NA	NA	NA	NA	NA	NA	0	0	0
Residential Other	5	5	5	5	5	5	5	5	4
CHEMICAL & ALLIED PRODUCT MFG	***183***	***183***	***183***	***183***	***183***	***183***	***158***	***160***	***165***
Organic Chemical Mfg	NA	NA	NA	NA	NA	NA	0	0	0
Inorganic Chemical Mfg	NA	NA	NA	NA	NA	NA	0	0	0
Polymer & Resin Mfg	NA	NA	NA	NA	NA	NA	0	0	0
Agricultural Chemicals	183	183	183	183	183	183	157	160	165
ammonium nitrate/urea mfg.	*111*	*111*	*111*	*111*	*111*	*111*	*72*	*73*	*76*
other	*71*	*71*	*71*	*71*	*71*	*71*	*85*	*87*	*89*
Other Chemical Mfg	NA	NA	NA	NA	NA	NA	*0*	*0*	*0*
METALS PROCESSING	***6***	***6***	***6***	***6***	***6***	***6***	***5***	***5***	***5***
Nonferrous Metals Processing	0	0	0	0	0	0	0	0	0
Ferrous Metals Processing	6	6	6	6	6	6	5	5	5
Metals Processing NEC	0	0	0	0	0	0	0	0	0
PETROLEUM & RELATED INDUSTRIES	***43***	***43***	***43***	***43***	***43***	***43***	***34***	***35***	***35***
Oil & Gas Production	0	0	0	0	0	0	0	0	0
Petroleum Refineries & Related Industries	43	43	43	43	43	43	34	35	35
catalytic cracking	*43*	*43*	*43*	*43*	*43*	*43*	*33*	*35*	*35*
other	0	0	0	0	0	0	0	0	0

Table A-8 (continued)

SOURCE CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998
OTHER INDUSTRIAL PROCESSES	***38***	***38***	***39***	***39***	***40***	***40***	***43***	***44***	***44***
Agriculture, Food, & Kindred Products	2	2	3	3	2	2	4	4	4
Textiles, Leather, & Apparel Products	NA	NA	NA	NA	NA	NA	0	0	0
Wood, Pulp & Paper, & Publishing Products	NA	NA	NA	NA	NA	NA	0	0	0
Rubber & Miscellaneous Plastic Products	NA	NA	NA	NA	NA	NA	0	0	0
Mineral Products	0	0	0	0	0	0	0	0	0
Machinery Products	NA	NA	NA	NA	NA	NA	0	0	0
Electronic Equipment	NA	NA	NA	NA	NA	NA	0	0	0
Miscellaneous Industrial Processes	35	35	36	37	38	38	39	40	40
SOLVENT UTILIZATION	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Degreasing	NA	NA	NA	NA	NA	NA	0	0	0
Graphic Arts	NA	NA	NA	NA	NA	NA	0	0	0
Dry Cleaning	NA	NA	NA	NA	NA	NA	0	0	0
Surface Coating	NA	NA	NA	NA	NA	NA	0	0	0
Other Industrial	NA	NA	NA	NA	NA	NA	0	0	0
STORAGE & TRANSPORT	***0***	***0***	***0***	***0***	***0***	***0***	***1***	***1***	***1***
Bulk Terminals & Plants	NA	NA	NA	NA	NA	NA	0	0	0
Petroleum & Petroleum Product Storage	NA	NA	NA	NA	NA	NA	1	1	1
Petroleum & Petroleum Product Transport	NA	NA	NA	NA	NA	NA	0	0	0
Organic Chemical Storage	NA	NA	NA	NA	NA	NA	0	0	0
Inorganic Chemical Storage	NA	NA	NA	NA	NA	NA	0	0	0
Bulk Materials Storage	0	0	0	0	0	0	0	0	0
WASTE DISPOSAL & RECYCLING	***82***	***86***	***89***	***93***	***93***	***93***	***84***	***84***	***86***
Incineration	NA	NA	NA	NA	NA	NA	0	0	0
Open Burning	NA	NA	NA	NA	NA	NA	0	0	0
POTW	82	86	89	93	93	93	84	84	86
wastewater treatment	*82*	*86*	*89*	*93*	*93*	*93*	*84*	*84*	*86*
other	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*0*	*0*	*0*
Industrial Waste Water	NA	NA	NA	NA	NA	NA	0	0	0
TSDF	NA	NA	NA	NA	NA	NA	0	0	0
Landfills	NA	NA	NA	NA	NA	NA	0	0	0
Other	NA	NA	NA	NA	NA	NA	0	0	0
ON-ROAD VEHICLES	***192***	***205***	***217***	***227***	***239***	***259***	***231***	***240***	***250***
Light-Duty Gas Vehicles & Motorcycles	159	171	181	188	190	204	156	159	164
Light-Duty Gas Trucks	32	34	35	39	48	54	69	73	78
Heavy-Duty Gas Vehicles	0	0	1	1	1	1	3	3	3
Diesels	0	0	0	0	0	0	4	4	5

Table A-8 (continued)

SOURCE CATEGORY	1990	1991	1992	1993	1994	1995	1996	1997	1998
NON-ROAD ENGINES AND VEHICLES	***6***	***7***	***7***	***7***	***7***	***7***	***9***	***10***	***10***
Non-Road Gasoline	1	1	1	1	1	1	1	1	1
Non-Road Diesel	2	3	3	3	3	3	3	3	3
Aircraft	NA	NA	NA	NA	NA	NA	3	3	3
Marine Vessels	1	1	1	1	1	1	1	1	1
Railroads	2	2	2	2	2	2	1	1	1
NATURAL SOURCES	***30***	***29***	***28***	***29***	***30***	***31***	***32***	***33***	***34***
Biogenic	30	29	28	29	30	31	32	33	34
MISCELLANEOUS	***3,727***	***3,770***	***3,814***	***3,869***	***3,924***	***3,979***	***4,113***	***4,163***	***4,244***
Agriculture & Forestry	3,727	3,770	3,814	3,869	3,924	3,979	4,113	4,163	4,244
livestock agriculture	*3,307*	*3,324*	*3,341*	*3,370*	*3,399*	*3,427*	*3,456*	*3,485*	*3,520*
fertilizer application	*420*	*446*	*473*	*499*	*525*	*551*	*657*	*678*	*724*
Fugitive Dust	0	0	0	0	0	0	0	0	0
TOTAL ALL SOURCES	4,331	4,390	4,449	4,521	4,589	4,665	4,772	4,837	4,935

Note(s): NA = not available.

"Other" categories may contain emissions that could not be accurately allocated to specific source categories.

Zero values represent less than 500 short tons/year.

In order to convert emissions to gigagrams (thousand metric tons), multiply the above values by 0.9072.

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TECHNICAL REPORT DATA

(PLEASE READ INSTRUCTIONS ON THE REVERSE BEFORE COMPLETING)

1. REPORT NO. EPA-454/R-00-002	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE NATIONAL AIR POLLUTANT EMISSION TRENDS REPORT, 1900-1998		5. REPORT DATE 3/1/2000 6. PERFORMING ORGANIZATION CODE USEPA/OAQPS/EMAD/EFIG
7. AUTHOR(S) SHARON V. NIZICH, ANNE A. POPE, LAUREL M. DRIVER (USEPA)		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. ENVIRONMENTAL PROTECTION AGENCY OFFICE OF AIR QUALITY PLANNING AND STANDARDS EMISSION FACTOR AND INVENTORY GROUP (MD-14) RESEARCH TRIANGLE PARK, NC 27711		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. 68-D7-0067
12. SPONSORING AGENCY NAME AND ADDRESS DIRECTOR, OFFICE OF AIR QUALITY PLANNING AND STANDARDS OFFICE OF AIR AND RADIATION US ENVIRONMENTAL PROTECTION AGENCY RESEARCH TRIANGLE PARK, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED TECHNICAL 1900-1998 14. SPONSORING AGENCY CODE EPA/200/04

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The Emission Factor and Inventory Group (EFIG) annually produces a publication on the trends in emissions of criteria pollutants. The emission estimates developed and included in the Emission Trends database have been utilized to support development of the National Particulates Inventory, in support of recent evaluations of the particulate matter and ozone NAAQS, in support of the National Air Toxics Assessment, and to satisfy requirements under CAAA406(g).

Included in this report are criteria, toxics, biogenics, greenhouse gases, and international criteria emission estimates.

KEY WORDS/DESCRIPTORS: CRITERIA AIR POLLUTANT, EMISSIONS TRENDS, GREENHOUSE GASES, BIOGENICS, AIR TOXICS, INTERNATIONAL EMISSIONS.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI FIELD/GROUP
AIR EMISSION TRENDS AIR POLLUTION AMMONIA BIOGENICS CANADA CARBON MONOXIDE NITROGEN DIOXIDE NITROGEN OXIDES	OZONE PARTICULATE MATTER SULFUR DIOXIDE TOTAL SUSPENDED PARTICULATE TOXIC COMPOUNDS VOLATILE ORGANIC COMPOUNDS	AIR POLLUTION CONTROL AIR POLLUTION RESEARCH AIR POLLUTION TRENDS	

18. DISTRIBUTION STATEMENT UNLIMITED	UNCLASSIFIED	21. NO. OF PAGES 236
	UNCLASSIFIED	22. PRICE

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